

THE DUALITY OF MATTER AND WAVES

ABSTRACT

A quantum measurement may detect a particle or a wave. The bias of the observer appears to influence the outcome of the experiment. Newton's laws of motion are not dependent upon the observer. The nature of the influence that the observer imparts upon the observed is mysterious. This author contends that observations progress through the action of the quantum transition. Matter and waves are both composed of undulating fields. The local fields of matter are pinned into the structure of matter at elastic discontinuities. Vibration at a specific frequency shakes the fields free from the grip of the discontinuity. The process of vibration is that of the quantum transition. The radiational fields of light are not attached to a discontinuity. They propagate at the luminal velocity.

THE UNIVERSE IS COMPOSED OF PARTICLES

Sir Isaac Newton (1643 –1727) proposed that light consists of particle like corpuscles. Arthur Compton (1892 - 1962) measured the angle of rebounding X-rays and discovered that they bounce like particles. This result confirmed Newton's hypothesis. In the late 19th Century, it was discovered that the spectrum of a black body contains much less ultraviolet radiation than classical wave theory predicted. Max Planck (1858 – 1947) came up with a solution to this problem. His solution employed particles of light. These particles are called photons. The energy of these photons varies directly with their frequency. Planck's particle construct solved the ultraviolet problem by showing that the higher frequency ultraviolet photons are not energetically accessible. Albert Einstein (1879 - 1955) applied Planck's constant to the photo-electric effect. He showed that the maximum energy of an ejected electron equals the energy of the absorbed photon. These observations show that light is composed of particle like things.

The ancient Greek philosopher Democritus (60 BC - 370 BC) proposed that matter is constructed of particles. These particles are the smallest unit of the substance that still retains the properties of the substance. The chemist John Dalton (1766 – 1844) offered some of the first theoretical proof of Democritus's proposition. His experiments revealed that particles (elements) combine in whole number ratios to form compounds. Ludwig Edward Boltzmann (1884 - 1906) extended this idea and showed that a gas consists of a collection of particles. Boltzmann discovered that the properties of a gas are established through a statistical interaction of its particles. Robert A. Millikan (1868 – 1953) experimented with electrically charged droplets. His experiments revealed, a first sub-atomic particle, the electron. Ernest Rutherford's (1871–1937) particle scattering experiments detected a few alpha particles that bounced directly back. This result revealed, a second sub-atomic particle, the nucleus. In the 20th Century the tracks, of a host of sub-atomic particles, were directly observed in a bubble chamber. These observations show that matter is composed of particle like things.

THE UNIVERSE IS COMPOSED OF WAVES

Christiaan Huygens (1629 - 1695) proposed that light is a wave. The amplitude of the light wave determines its intensity and the frequency of the light wave determines its color. The diffraction of light, by a prism, seemed to support this hypothesis. The dispersion of light, that passed through a pinhole, is also wave like property. Thomas Young (1773 –1829) offered some of the first theoretical proof of Huygens' proposition. Young passed light through two closely spaced slits. An interference pattern was produced as the light was projected on a screen. This interference pattern revealed the wave like nature of light. Radio technology was developed in the Twentieth Century. This technology directly displays the amplitude and the frequency of a radio wave (a form of light) on an oscilloscope. These observations show that light is composed of wave like stuff.

Louis deBroglie, (1892 –1987) proposed that matter is a wave. In 1927, Clinton J. Davisson and Lester H. Germer of Bell Labs conducted an experiment in which an electron was passed through finely divided slits.¹ An interference pattern was produced. It was discovered that the electron exhibits wave like properties. These observations show that matter is composed of wave like stuff.

It appears that the substance of the universe simultaneously exists as both a particle and a wave. The

property that emerges depends upon the nature of the observation. This duality is a fundamental mystery.

PROPOSED RESOLUTIONS

Niels Bohr (1885 – 1962) produced an atomic model that contained a particle like nucleus. Particle like electrons orbited around this nucleus. These electrons carried an amount of angular momentum that is an integer multiple of Planck's constant. Angular momentum is the product of length, velocity, and mass. None of these terms was ever produced from a fundamental analysis. Bohr's model gave the radii of the atomic orbits and described the frequency of the emitted photon. The model did not reveal the mechanism that binds the electron to a state, determine the probability of transition, or produce the intensity of the atomic spectra.

Werner Heisenberg (1901 - 1976) developed a mathematical technique that produced intensity of the spectral lines. His technique employed matrix mechanics and the mathematical function known as the Hamiltonian.² The Hamiltonian describes particle interactions as a function of their energy. The correspondence principle was invoked. It states the energy drop in a quantum system is equivalent to the amplitude of a classical system. The position of the particle was obscured within the Hamiltonian and the amplitude of the particle's vibration was brushed aside with the help of the correspondence principle. The question of the fundamental nature of the substance was avoided.

Erwin Schrödinger (1887 - 1961) proposed that matter is a wave. His solution was slightly better than Heisenberg's in that it incorporated deBroglie's electron waves. The use of the deBroglie wave presented a conceptual problem. The deBroglie wave consists of a packet of waves that travel together at the group velocity V . The length of the packet decreases as its velocity increases. It is a curious mathematical construct with no classical analog. Its was accepted because it produced results. Schrödinger encountered a second conceptual problem. How do the discrete properties of matter naturally emerge from a continuous wave? He proposed that the superposition of an infinite number of waves localized the wave function.³ Wave patterns repeat at intervals. The solution suggests that the particle appears at intervals in remote locations. The particle nature of matter did not spontaneously emerge from the analysis and Planck's constant had to be injected ad-hoc into the solution.

Max Born (1882 – 1970) offered a solution. This solution is known as the Copenhagen interpretation. It proposes that matter's deBroglie wave is not real. It exists in configuration space. The amplitude of this wave represents the probability that a particle of matter will reside at certain location. A particle emerges, from the probability wave, upon the immediate collapse of the wavefunction. The solution attempted to extract a particle out of a wave and to solve the problem of wave particle duality. The interpretation did not provide for a mechanism to bind the electron to a state, disclose the whereabouts of configuration space, or explain how a continuous wave collapses at velocities greater than light speed. Schrödinger and Einstein never accepted this interpretation. The nature of the substance of the universe remained a mystery. It appeared that the properties of nature were not reconcilable.⁴

ZNIDARSIC'S INTERPRETATION

This model revealed the mechanism that binds the electron to a state. The binding mechanism is classical. Classical systems are constructed by fastening components together. Fasteners are mechanical discontinuities. The same binding mechanism can attach a field. The electromagnetic field is, for example, pinned into the structure of a superconductor by introduced defects (discontinuities). This interpretation states that the natural force fields are pinned into the structure of matter at elastic discontinuities. Discontinuities naturally emerge when the intensity of a field exceeds the ability of space to support that field. The discontinuity acts as a pilot and replaces Heisenberg's and Schrödinger's superposition of waves construct. The use of a single binding mechanism is a simplification. This simplification is in accordance with principle of Occam's razor.

Charles Coulomb (1736 – 1806) studied the force between electrical charges. He qualified the energy E contained by the interaction of two electrical charges Q . Coulomb's formulation, reference Equation #1,

did not disclose that mechanism that binds an electron to a state.

Equation #1

$$E = \frac{2Q^2}{4\pi\epsilon_0} (1/r)$$

The energy contained by a classical spring is proportionate to the product of the spring constant K and the square of the displacement x. (ref Equation #2). This formula is usually employed with a fixed spring constant K and a variable displacement x.

Equation #2

$$E = \frac{1}{2} Kx^2$$

Znidarsic regrouped Coulomb's constants into a form that expresses electrical energy in terms of the elastic displacement of a spring. This formulation describes this energy in terms the movement of the fixed displacement $2r_p$ within the variable elastic medium K_e .

Equation #3

$$E = \frac{1}{2} K_{-e} (2r_p)^2$$

The elastic discontinuity $2r_p$ was exposed. The radius of this discontinuity is twice that of the maximum extent of the proton. It equals the classical radius of the electron. Mass and kinetic energy are pinned into the structure of matter at this discontinuity. The phase velocity of disturbances within the pinned fields is luminal. The group velocity V of the packet is that of the discontinuity. The condition resembles that of stuck light. deBroglie suggested that the matter wave naturally emerges, from the superposition of the Compton wave and its doppler shifted reflection, under this condition.⁵ The properties of Special Relativity also emerge as a condition of stuck light.^{6,7}

The variable elastic constant of the electron, refer to Equation #4, was produced as a result of the regrouping of the electrical constants. This author placed this elastic constant into a formulation and determined the atomic energy levels and the intensity of the atomic emission. (Refer to Infinite Energy Sept. 09)⁸.

Equation #4

$$K_{-e} = \frac{F_{\max}}{r}$$

The solution was based on the idea the quantum transition progresses at velocity V_t . The velocity is a single term classical parameter. It is proportional to the product of the electronic Compton frequency f_c and the extent of the elastic discontinuity $2nr_p$ (refer to Equation #5).

Equation #5

$$V_t = (f_c / n)(2\pi nr_p)$$

This author presented his theorem at a conference of the American Nuclear Society in 2000.⁹ It describes the action of V_t . It is, "The constants of the motion tend toward the electromagnetic in a Bose condensate

that is stimulated at a dimension frequency of V_t ". The convergence of the motion constants is an affect of an equalization in the strength of the magnetic component of the electrical, gravitational, and nuclear forces. The equalization in the strength of the forces matches the impedance of the interacting states and allows the fields to slip into a new configuration. Energy flows, the wavefunction collapses, the quantum transition proceeds, and particles emerge from waves. The constant V_t , like Planck's, has produced the energy levels of the atom and the intensity of spectral emission. The convergence of the motion constants provides a clue as to the origin of V_t . It is the velocity of light within the transitional quantum state. It is also the velocity of sound that around the elastic discontinuity. The equalization of these velocities is the effect that pulls the motion constants together. V_t is an emergent property of the classical electron and, as such, it is fundamental to Planck's constant. This paper extends the prior analysis and produces the energy of the photon.

THE PARTICLE OF A LIGHT WAVE

Light is not attached to an elastic discontinuity. The geometry it experiences is approximately that of a flat plate capacitor. The capacitance C of a flat plate capacitor of area A and spacing D is given in Equation #5.

Equation #5

$$C = \frac{e_o A}{D}$$

The area A equals the wavelength of the photon squared. The distance between the plates D equals one wavelength. The capacitance experienced by a photon is given in Equation #6.

Equation #6

$$C = \frac{e_o \lambda^2}{\lambda}$$

The great scientists described the energy of a photon in terms of its frequency. The energy of classical wave is a function of its amplitude. This discrepancy has been a long standing mystery. The principle of quantum correspondence was invented in an attempt to circumvent this problem. It proposes, with some slight of hand, that the frequency of quantum system appears as an amplitude in a classical system. This author has rejected this proposition and has shown that that the energy, of a quantum field, is a direct function of its amplitude. Equation #6 reveals that the capacitance of a photon, during emission, varies directly with its wavelength. The voltage produced by an electrical charge increases as its capacitance decreases. The energy contained by a photon is proportionate to the amplitude of its voltage. The action, of this voltage, replaces the principle of quantum correspondence.

According to this author's model a spin one-half electron combines with the spin one-half transitional state to form a composite spin-one Boson. The superposition of the two states cancels the amplitude of the megahertz-meter vibration. The probability of interaction is reduced and the quantum transition proceeds as a virtual Boson. Photons, which are real Bosons, exist at twice V_t . (ref. Equation #7).

Equation #7

$$f\lambda = 2V_t$$

Equation #7 was solved for length.

Equation #8

$$\lambda = \frac{2V_t}{f}$$

The amplitude of the photon, as expressed by its voltage, was built into the foundation of the analysis through the incorporation of Equation #6. This amplitude is restricted to discrete levels through the action of the transitional quantum state. This limitation was qualified through the interjection of Equation #8. The result, Equation #9, qualified the relationship between the capacitance and the frequency of the photon. The capacitance C expresses the geometry experienced by the electric field of the photon. The conservation laws place no limits on the frequency f, the capacitance C, or their rate of change. The geometry, of the traveling photon, is that of a boundless wave. Its state is, as Feynman called it, the sum of every possible history.¹⁰ Light, in this state, simultaneously passed through the two slits in Thomas Young's experiment. The spin of the photon is, however, fixed the ratio of C and f. The interaction couples the electron's spin to its extent. This entanglement may produce, as Einstein called it, "a spooky interaction at a distance".¹¹

Equation #9

$$C = \frac{2e_0 v_t}{f}$$

The energy E contained by an electric charge is a function of capacitance C. This relationship is expressed in Equation # 10.

Equation #10

$$E = \frac{Q^2}{2C}$$

Deterministic classical reality emerges from probabilistic quantum waves during the process of quantum transition. The photon's wavefunction abruptly collapses upon an elastic discontinuity. The transition is facilitated by a convergence in the motion constants. One half of the quantum information is lost in the crash. The photon appears as an affect of the process. This is the domain of Einstein's photon electric effect. The domain was qualified through the simultaneous solution of Equations #9 and #10. The result (Equation #11) describes the energy of a particle like photon in terms of the transitional quantum state.

Equation #11

$$E = \left[\frac{Q^2}{4e_0 v_t} \right] f$$

Planck's constant emerged from the terms within the brackets []. Planck's constant was substituted for the quantity within the brackets. Planck's famous photoelectric relationship was produced. This relationship, refer to Equation #12, describes the energy E of the emitted photon in terms of its frequency f.

Equation #12

$$E = hf$$

The energy of a photon is a classical function of its amplitude. This amplitude is expressed in volts. The photon is emitted at points where the electromagnetic and gravitomagnetic motion constants converge. The photon exhibits particle like properties at these points. The geometry of the photon, at other points, is that of a wave.

CONCLUSION

The nature of the substance of the universe has been the subject of debate since antiquity. Some philosophers have suggested that the universe is composed of particle like things. Others have suggested that the universe is composed of wave like stuff. In the 20th Century, it was discovered that the quantum realm consists of wave like stuff. This stuff is that of the subjective. It is governed by chance and exhibits many unusual properties. Quantum entanglement is the most mysterious of these properties. The process of quantum transition converts this wave like stuff into particle like things. These things exist in the realm of the objective. They obey Newton's laws and interact in a deterministic clock like fashion. It is believed, today, that size is the barrier that separates the wave like quantum continuum from the particle like classical reality.

The process of cold fusion was discovered in the late 20th Century. Scientists have suggested that the cold fusion reaction proceeds at the fringe of our contemporary understanding. This author has shown, to the contrary, that the process of cold fusion rests squarely at the center of a debate that has been raging for hundreds of years. The observable results of the cold fusion experiments have exposed the nature of the door that divides the quantum and the classical realms. A quantum wave is transformed into a classical particle as it follows a path through the door. The speed of the passage invokes the magic of a convergence in the motion constants. The range and strength of the force fields are adjusted, through this action, to the dimensions of the opening. The terms that describe this passage have produced the energy levels of the hydrogen atom, the probability of transition, and the energy of a photon. These constructs form the foundation of our contemporary understanding of the natural universe. The path of the quantum transition has been exposed and a new perspective, on the nature of reality, has emerged.

nomenclature

ϵ_0	=	$8.854 \times 10^{-12} \text{ A}^2 \text{ s}^4 \text{ kg}^{-1} \text{ m}^{-3}$
F_{\max}	=	29.05 Newtons
f_c	=	1.236×10^{20} hertz
r_p	=	1.409×10^{-15} meters
Q	=	1.602×10^{19} Coulombs
V_t	=	1.094×10^6 hertz-meters

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Biography

Frank Znidarsic graduated from the University of Pittsburgh with a B.S. in Electrical Engineering in 1975. He is currently a Registered Professional Engineer in the state of Pennsylvania. In the 1980's, he went on to obtain an A.S in Business Administration at St. Francis College. He studied physics at the University of Indiana in the 1990's. Frank has been employed as an Engineer in the steel, mining, and utility industries. Most recently he was contracted by Alstom Power to start up power plants in North Carolina.