



Is Reality Digital Or Analog? Physics Is Undecided - A *Beautiful Universe* Theory's Answer.

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Abstract:

In Section 1 the three words comprising the question “Is Reality Digital or Analog” <D/A?> are defined further. In Section 2 Key aspects of physics are probed using <D/A?> and contradictions pointed out. The incompatibility of an analog Gravity and an analog-digital Quantum Mechanics are traced back to Einstein’s point-photon and his flexible spacetime. Without a unified theory it is fruitless to decide about the basic makeup of the universe. Space and Time, Electromagnetic Radiation, Matter and Gravity, and Quantum Mechanics in general are examined with <D/A?>. In Section 3 <D/A?> is answered within a new *Beautiful Universe*⁴⁸ model ToE ‘Theory of Everything’ proposed from first principles. A universal lattice of identical spherically-symmetrical interacting dielectric nodes exchanging angular momentum through magnetic induction, in units of Planck’s constant (h) is proposed. The 3 space dimensions and time, vacuum, matter, radiation, dark energy and dark matter are derived from the causal, local self-assembly and Hamiltonian evolution through interactions between neighboring nodes. Each node represents a miniature Bloch sphere, at a variable rate depending on node rates of rotation, and the orientation of their axis. The model explains matter as nested polyhedral patterns of nodes locked by tensegrity yet capable of soliton-like translation. Quantum effects are the result of the diffusion of momentum in a wave pattern through the lattice. Gravitational potential equals node rotation, but its force is due to the spring-like twisting geometry of the node axes in the regions of space between matter.

1- Examining the Terms of The Question ‘Is Reality Analog or Digital?’

There are many versions of reality, depending on the person, animal or robot who experiences it. The question “Is Reality Digital or Analog” seems to assume there is one absolute physical Reality out there which encompasses everything (including persons, animals and robots), and assumes further that physics is the best way to understand it, rather than philosophy, prayer, inherited dogma or untutored everyday interaction with the physical world. The question reduces to <Physics=Analog/Digital ?> or simply <A/D?>

<A/D?> reflects the incredible ability of digital computers to model various aspects of analog reality. Seemingly almost every experience has, or one day soon will be modeled, simulated and experienced in realistic 3D. So much so that science-fiction writers as in *The Matrix* and even some serious thinkers can ask whether our reality is merely someones’ computer simulation¹. Are we a particularly sophisticated version of a Cellular Automata² the famous program that demonstrated how digital pixels obeying a simple algorithm can evolve into complex patterns with a ‘life’ of their own? For all their success computers may no longer remain digital based on two-bit 0-or-1 state transistors. Will quantum computers’ qubits³ having intermediate states between 0 and 1 still be called ‘digital’ ? Perhaps, since digits can merge with each other smoothly through decimals. <A/D?> =<Continuous/Discrete?>.

A digital description implies separate items or *things* that are counted. Computer bits exist in silicon or electrons. Do the digital or discrete units of the universe merely exist as pure concepts? Or, much like the old idea about electromagnetic waves needing an ether to propagate through, are the universe’s presumed digital discrete units made up of things embedded in an analog background? The question becomes circular. In my own theory to be described in Section 3, the universe is made up entirely of a lattice of one type of node whose mutual interactions define physics. In this case one can rephrase McLuhan’s saying “the medium is the message”⁴ as “the nodes are the physics”. The physical universe



would then be a sort of 3D abacus⁵ or linkage, akin to analog mechanical computers like Babbage's Analytic Engine⁶ or related to the gears of the 'molecular aether' proposed by Maxwell⁷.

Mathematically speaking, are digital and analog always uniquely contradictory characterizations? Continuous functions may include point singularities when division by zero is attempted which occurs when describing the Big Bang. Or, according to Catastrophe Theory⁸, continuous functions can have 7 types of discontinuity such as localized cuts or folds. If these discontinuities occur regularly such regions may well be regarded as digital 'islands' as when a plane intersects an undulating egg-crate shaped surface. Is there such a universal continuous analog fabric whose energy contours appear to us as discrete digital elements? Do we live in a 3D *Flatland*⁹ within other larger hidden dimensions?

Is Nature neither digital or analog? Could Nature in all its vastness be neatly classified by the notions of a complacent species that has only existed for a blink in cosmological time, from the vantage point of a remote planet at the rim of a galaxy, one of billions in the Universe? What does our physics tell us about these questions?

2. Physics As We Know It Is full of Digital/Analog Contradictions.

<D/A?> reflects a prevailing need to understand Nature at its most fundamental level – In the past this was the domain of philosophy or religion with holistic views that amounted to the Theory of Everything (ToE) of their time. Modern physics takes a pragmatic approach, satisfied to tackle questions about various aspects of nature piecemeal, and with demonstrable success. But when Nature is regarded as a whole, there is no consensus about what it is or how it works. Complicating the answer to <D/A?> is the fact that since the mid 1920's most physicists have come to accept the paradoxes presented by various interpretations of Quantum Mechanics (QM), as something natural and not to be questioned further. This fudge should be resisted at all costs. The human brain has evolved over millions of years made of and reacting to the molecules that make up both matter and living organisms. The least to be expected is that they both follow the same natural effects of nature; it should not be deemed impossible that we can understand these basic laws directly and simply. As it is, physics is a hodgepodge of incomplete and/or contradictory theories.

A <D/A> dichotomy characterizes the core concepts of the two pillars of contemporary physics and is yet another symptom of the deeply unsatisfactory state it is fundamentally in: General relativity (GR), Einstein's theory of gravitation governing very large masses and distances is analog, using equations of continuous variables. (QM), the theory describing the very small atomic world) in its Heisenberg matrix formulation and its use of discrete energy packets in the miniscule units of Planck's constant of action (h), may be said to be analog. Within (QM) itself the dual nature of the photon as an (analog) wave - (digital) particle is another example of this obstacle to a unified theory. Intuitively one feels that Nature should be more consistent, and Roger Penrose' call to 'start all over'¹⁰ should be taken seriously.

2.1 Are Space & Time <D/A?>

An ether filling all of space is a centuries-old idea. In 1861 Maxwell⁷ drew a diagram of a dielectric ether featuring rotating gear-like elements. Hertz¹¹ wondered if everything including the vacuum (and matter) was made up of electrical elements, presumably digital. In Special Relativity (SR)¹² Einstein re-packaged ideas by Lorentz, Fitzgerald (and unwittingly, Poincare's relativity) into his elegant and conceptually imaginative theory and banished the need for an ether. Although Einstein thought of spacetime as an (analog) "continuum" existing without an ether, he himself lectured in 1920¹³ on the need for an ether to provide points on a grid where his conceptual clocks and measuring rods can be placed. A mesh with clocks at its vertices can easily be regarded as a digital entity. Dirac, who had conceived matter as a (digital) 'sea of electrons'¹⁴ later emphatically stated that there was a need to reintroduce the concept of an ether in physics¹⁵. Recently the ether has reemerged in the guises of a (digital) Loop Quantum Gravity¹⁶ or of an (analog) Space-time Foam¹⁷, and also in theories such as my



own (BU)⁴⁸ theory where the universe is made up of a crystal-like lattice of separate nodes.

Recent papers published in FQXI¹⁸ and elsewhere⁴⁸ conclude that there is no inherent time dimension in Nature. Logically spacetime then loses its entire *raison d'être*, and if other concepts can replace it they should be adopted. The more humdrum formulations embodied in the Lorentz Transformations¹⁹ before Einstein transformed them in (SR), describe how it is the length of an object measured from another inertial frame of reference, *not space itself* that contracts when the object moves. And that it is clocks that slow down, *not time itself that dilates*. Without a time dimension clocks merely label successive or rather instantaneous states of the universe, even though human memory and learning make us experience this only real state as a continuous flow from past to future.

If time does not exist, then the significance, if any, of the Planck Units²⁰ (Time, Length, Mass etc.) will have to be re-examined from scratch, particularly within theories that envisage the universe as made up of individual (digital) building blocks at the smallest scale.

2.2 Is Electromagnetic Radiation <D/A?>

Newton's concept of analog light particles or corpuscles²¹ was seemingly disproved in the early 19th c. when Thomas Young²² used the double slit experiment to demonstrate the analog wave nature of light. Apart from his discovery of the interference of light, Young interpreted diffraction as a gravitational effect due to a thickening of the air in the environs of the aperture: it causes light rays to bend in a gravitational potential, much as they would in the variable refractive index (n) in layers of air at different temperatures that cause mirages²³. A gravitational refractive index was also proposed by Eddington²⁴. Einstein in his seminal 1905 paper on the photoelectric effect²⁵ proposed that light was a particle yet, having energy in multiples of Planck's constant (h). Einstein stated that his analysis was based on "statistical probability" - that what was later called the photon occupies a point in space, and does not merely come in discrete packets of energy. The quintessential <D/A> contradiction, that of the photon's dual nature as both particle and wave was born. Nowadays this duality is accepted as a matter of course, rather than considering it as a fundamental conceptual scandal concerning our incomplete understanding of Nature that needs to be resolved.

Many eminent physicists resisted this concept of a geometrically discrete or digital photon but the lack of an alternate theory weakened their objections. Foremost among them are Planck, Millikan²⁶, who performed the experiments needed to prove Einstein's photoelectric relations, Bohr and his colleagues who put out the BKS²⁷ proposal, and most recently Lamb²⁸. Einstein's own famous words of his last years, "every fool thinks he knows what the photon is, but he is mistaken" should be kept in mind until a definitive ToE gives us the answer as to the exact nature of electromagnetism and its interactions with matter, and whether they are discrete or continuous phenomena.

2.3 Are Matter and Gravity <D/A?>

The Greek philosopher Democritus²⁹ proposed the existence of atoms, the quintessential analog answer to <D or A?>. Newton's theory of gravity as well as Einstein's (GR) both rely on continuous functions and are thus analog. As a background-independent theory of space-time distortions (GR) makes no provision for a possible granularity of spacetime. The 5th dimension in the Kaluza-Klein solution for (GR) is said to represent an ether made up of discrete 4-dimensional scalar points or 'radons'³⁰ so (GR) may be digital after all. The mathematical symmetries of the Standard Model and of the recent (E8) proposal³¹ suggest the presence of a corresponding analog physical crystal-like pattern in Nature where such symmetries are embodied as space-groups.³² An analog universe will not have such naturally occurring planes of reflection, just a continuous mathematical mush. String Theory is decidedly analog when it comes to the discrete numbers of its multiple dimensions.



2.4 Is Quantum Mechanics <D/A?>

The question of the point-like nature of the photon took on an even more fundamental importance in the early 1920's when the tenets of quantum mechanics were being created. In hindsight it is clear why this idea prevailed: First Taylor's faint-light diffraction experiments³³ were taken to be proof of this (although there is an alternative argument known as the semi-classical theory, which states that the point-like behavior only occurs because of individual atoms' absorption and emission events in the sensor.) Then the Compton effect³⁴ was taken as final proof of the point-like nature of the photon - although recent work shows that a wave interpretation is equally valid³⁵. As a result it became impossible to interpret de Broglie's and Schrödinger's concepts of matter as a true physical wave using the point photon concept. Apart from the quantum phase term in the Schrödinger Equation, how can a wave be made up of points? Heisenberg neatly side-tracked the issue when he proposed his matrices which by their nature are digital, except that there is an infinite number of them, so they tend to add up to a quasi-analog world. On the other hand Heisenberg cited the (analog) wave nature of diffraction to illustrate his Uncertainty Principle³⁶. Soon afterwards Born's (analog) probability wave was born, transforming what ought to be a simple, beautiful physical concept - for nature prefers simplicity - into a weird cluster of confusing concepts and speculations: zombie cats, instantaneous communication at a distance, contradicting the limit on the speed of light (c) in (SR), hidden variables, multiple universes and so on, that have plagued (QM) and physics until now.

Ironically it was Einstein who complained the loudest about the probabilistic interpretation of physics. God may not play dice, but now that our beloved physicist is up there, He may be sorely tempted to do so to prove a point, perhaps using a hyper-cubic 4-dimensional tesseract³⁷ die with point photons on its 24 facets!

3. Is the Beautiful Universe Theory <D/A?>

To give my honest answer to <D/A?> I will, by necessity, have to present not what other physicists have concluded, but for all that they are worth, my own conclusions. These are based on my theory about how things might work, not in the Universe itself, because it is impossible to read its workings directly, but through a model, a theoretical framework I call *Beautiful Universe* (BU)⁴⁸. This theory, explained at length elsewhere⁴⁸ is mostly qualitative, and needs completing, simulation and testing experimentally at the hands of far more capable researchers. It is beyond the scope of this paper to explain how (BU) reverse-engineers (SR), (GR), (QM) and other aspects of modern physics and attempts to reinterpret them in a simple coordinated way. Fortunately, its handful of simple physical assumptions are clear, and merely presenting those without justification will give my <D/A?> answer.

3.1 What (BU) does not assume:

The two Einstein (SR) premises and his point-photon conclusion as well as the resulting Born probabilistic interpretation of (QM) are not used as first principles in (BU). *There is no need to assume that:* 1- A photon is a point particle as discussed above. 2- That the same equations (Einstein said "laws of physics") have to be the same for all inertial frames of reference. In (BU) all interactions are local and causal i.e. absolute. By extension the entire universe constitutes an absolute framework. Relativistic, i.e. Lorentzian effects only apply in (BU) when observations of inertial frames are made. This is in contrast to Einstein who postulated that: 3- The speed of light is constant, i.e. observations are absolute, resulting in a relativistic framework of space contraction and time dilation depending on the motion of the inertial frame. 4- That probability waves are in any way real and are behind observed quantum effects. Suspending belief in these concepts and others such as: 5- The physical reality of the Higgs and force exchange particles in the Standard Model, is a necessary first step to start a reconstruction of physics on new first principles.

3.2 What (BU) assumes:

1- The entire universe, including the vacuum, energy, matter, antimatter, radiation, dark energy and dark matter is made up of one type of elementary dielectric particle-like node or building block.

2- A node is, or acts as, a spherically symmetrical point particle that can rotate and have angular momentum (in units of Planck's constant (h)), around any axis orientation measured relative to those axis of its neighbors, thereby becoming 'magnetized' with (+) and (-) poles. Because of (- -) and (++) repulsion, and (+ -) attraction nodes self-assemble aligned with their axes parallel, in a state of maximum entropy, most probably in an FCC (face-centered-cubic Kepler packing) (FIG. 1).

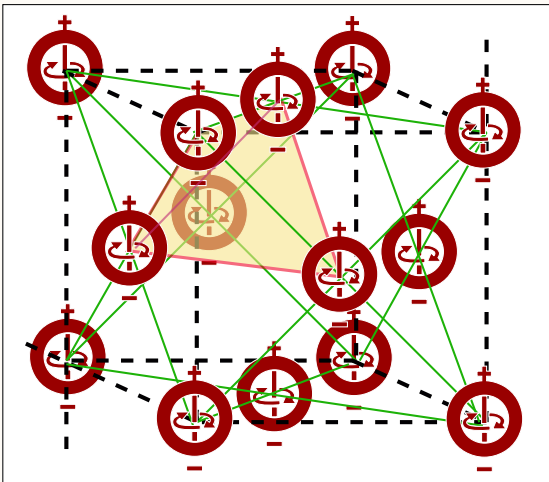


FIG. 1 Self-assembly of magnetic dipole nodes oriented in the same direction as a Kepler packing. Each unit of the packing forms a cube with a node at each corner, with another node where the cube's diagonals cross. The smallest regular volume made up of four nodes would be a tetrahedron (shaded).

3- A node can transfer all its angular momentum without loss to neighboring nodes when they spin on an axis normal to their previous mode thereby creating forward momentum (FIG.2). The rotation of each node creates the energy or density state that is the local potential (Φ). The rate of transfer of momentum from node to node depends indirectly on (Φ) having a maximum of c_0 (the speed of light in the vacuum free of gravitational effects) when (Φ)=0, and at a rate $c_v < c_0$ when (Φ)>0 .

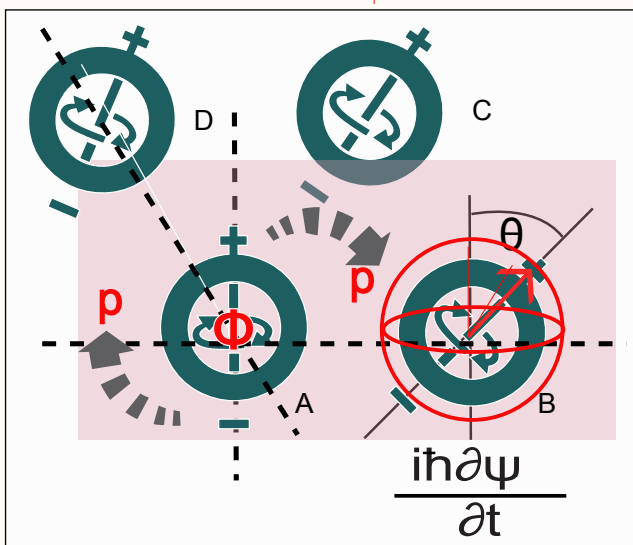


FIG. 2 Node A spins on its own axis (internal arrows) defining the local potential energy (Φ), with angular momentum in units of Planck's constant (h) but if it has forward momentum (p) it causes adjacent nodes (B,C,D) to tilt accordingly. The phase term from the Schrödinger equation and a 'qubit' Bloch sphere (red) remind that this action is the root 'cause' of quantum effects in (BU).

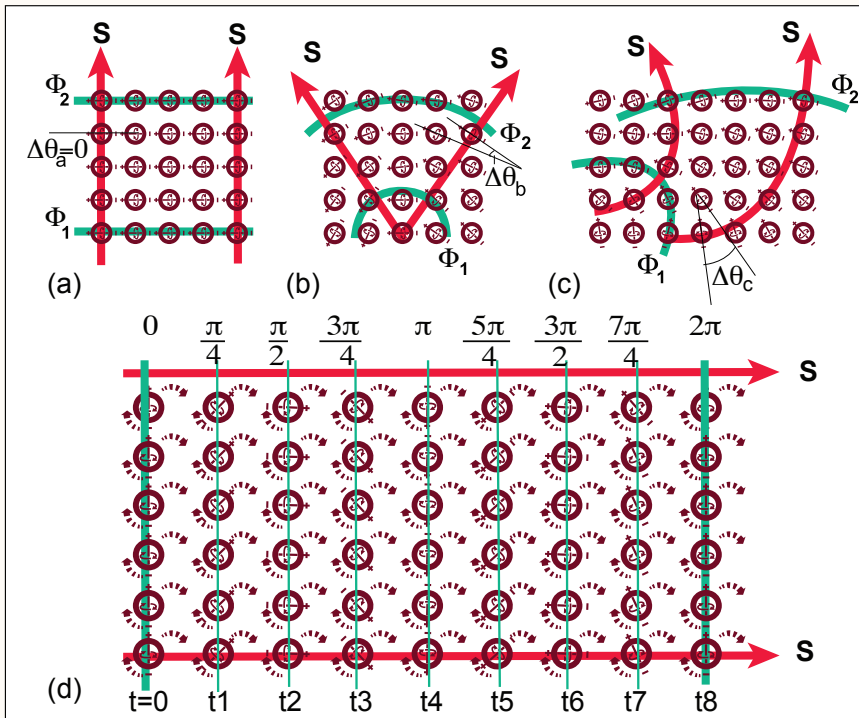


FIG. 3 Steady states and a wave in a vacuum. The red lines are the streamlines or geodesics orthogonal to the equipotentials Φ (green) along which the node axes align themselves. Curvature or acceleration is $\Delta\theta$. Axes' twisting in planes normal to the streamlines cannot be shown in this 2D view. (a) A homogeneous potential field. (b) a spherical field, and (c) an inhomogeneous potential field. (d) A plane wave. The nodes always rotate in place but their angular momenta (dashed arrows) are transferred to the adjoining nodes. Axis orientation along wavefronts show the phase there (FIG. 6).

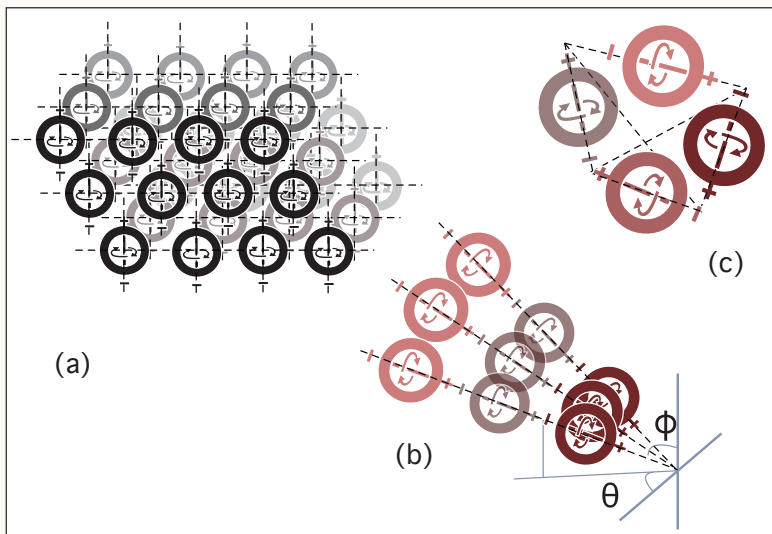


FIG. 4 The alignment of adjacent nodes define the properties of various regions of the universal lattice. (a) An absolute vacuum or region of dark matter with all the nodes parallel and their polarity unidirectional. (b) An electrostatic field with nodes locked end-to-end but their polarity is more or less parallel. Node axis alignment allows absolute directions (θ, ϕ) to be defined locally and in the universe as a whole. (c) Extreme twisting of node axes create the tightly locked regions of a simple particle of 4 nodes in a tetrahedral pattern with a closed attractive chain of (+ -) poles.

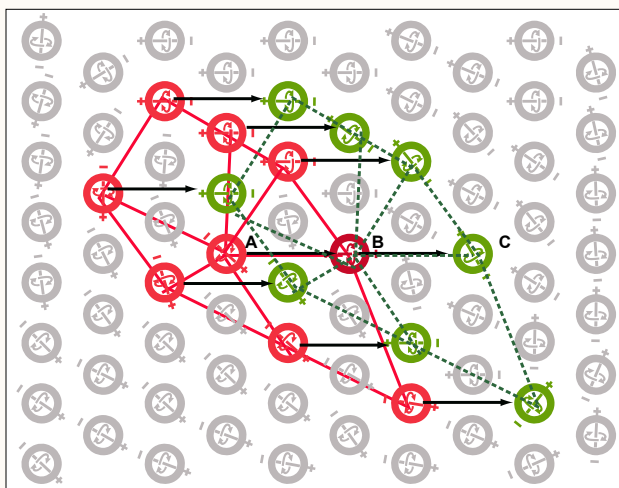


FIG. 5 A particle (red nodes) 'moves' to a new position (green nodes). In (BU) it is only the pattern of angular momentum that moves, not the nodes themselves, as in the 'moving' letters of a marquee display made up of light bulbs. The pattern self-convolutes during motion. Note for example the superposition of energy states in node (B) as the pattern sweeps across the nodes.

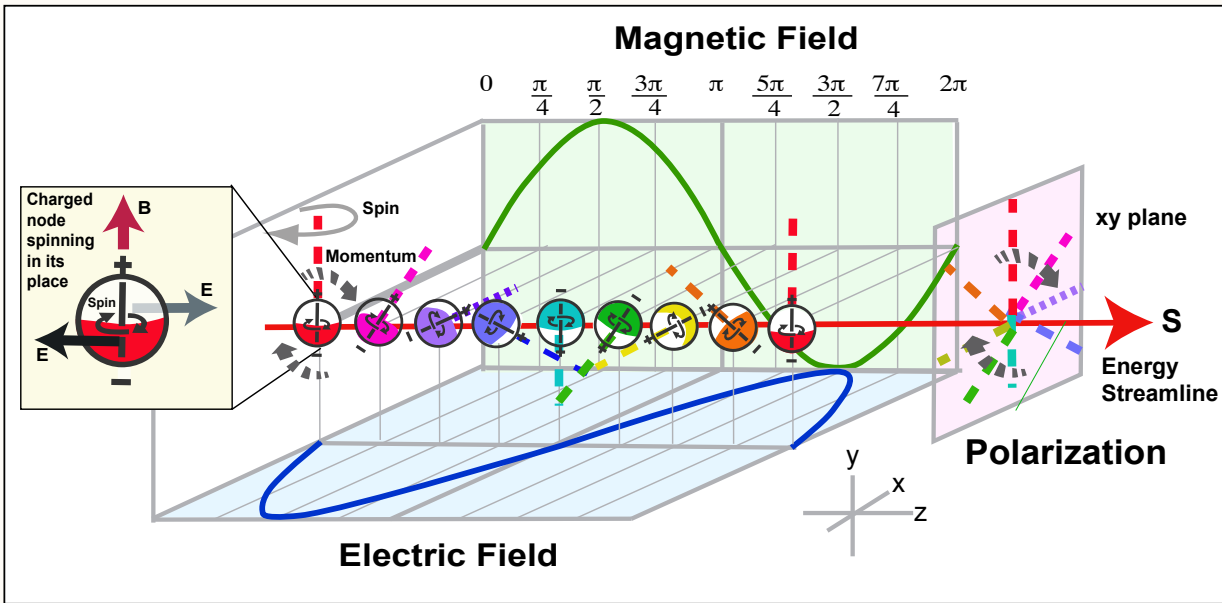


FIG. 6 Electromagnetic propagation along a geodesic (streamline) is the result of angular momentum transfer from node to node whose axes' orientation and angular momentum change sinusoidally. Axes rotation in a plane normal to the geodesic create polarization states.

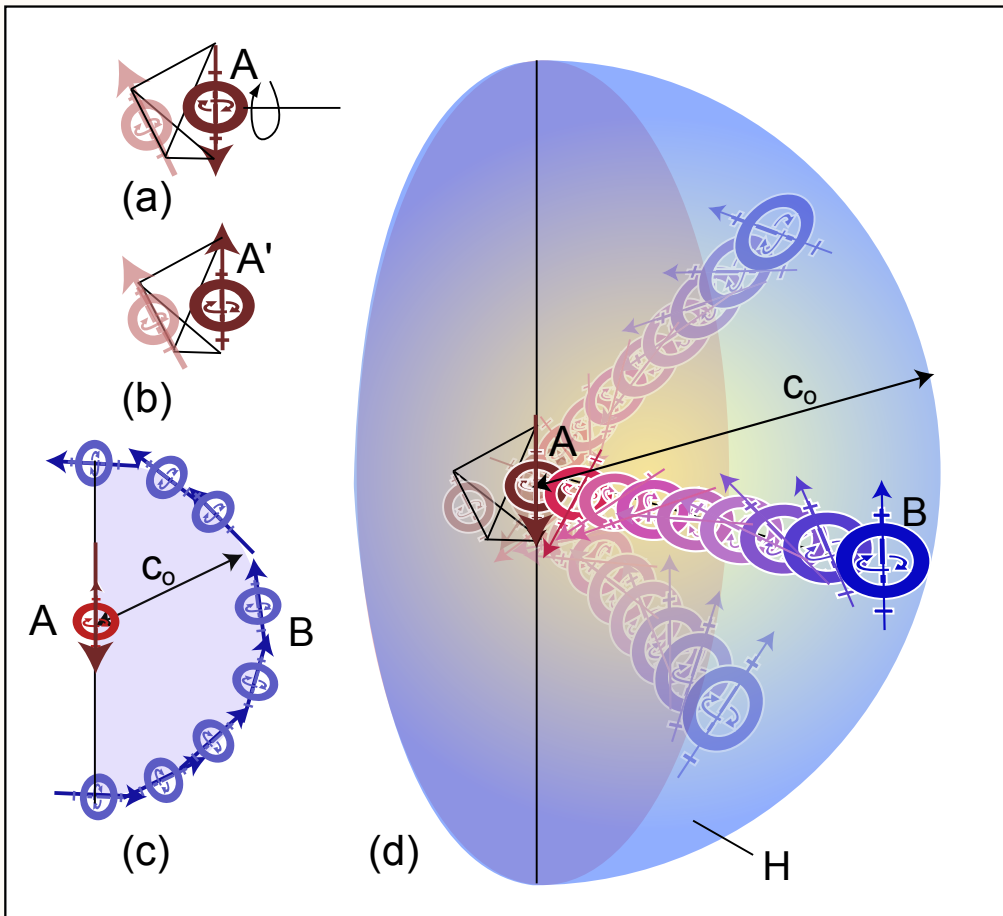


FIG. 7 A hypothetical example of matter releasing its locked energy. (a) Node A in vacuum is locked with another node to form a particle. (b) Forces (not shown here) force Node A to rotate by π about an axis normal to its spin axis, acquiring state A'. (c) The released momentum from A causes a twisting effect to be transferred radially from node to adjacent nodes, and after one second the effect reaches nodes such as B, aligned in a hemisphere H of radius c_0 (d) Lattice nodes on the surface of the hemisphere of surface area $2\pi c_0^2$ now contain all the momentum originally found in node A in its locked state. A reversed version of this process when surface nodes transfer their momentum inwards creating matter by twisting A' into locked matter A explains $E=mc_0^2$.

An ideal universe of nodes aligned with parallel axes and with all poles pointing in the same direction would be in a steady state. But when forward momentum causes a node to change its orientation even slightly the change spreads by induction in a domino effect to all other nodes in the universe as an evolving Hamiltonian with potential energy (Φ) (node rotation in place) and kinetic energy (p) (forward momentum) (FIG. 2). The Schrödinger Equation describes such a wave because of its complex phase (i) term: A node's rotations are its phases, the physical embodiments of a quantum Bloch³⁹ sphere, i.e. a unit qubit³. There is no duality in (BU): a wave energy pattern is embodied in a field of discrete nodes (FIG. 3).

4- As a result of systematic twisting of node orientation propagating throughout the universe, a pair or nodes or a cluster of nodes will align themselves locked with their opposite poles (+ -) in relative proximity, creating matter in nested polyhedral patterns.

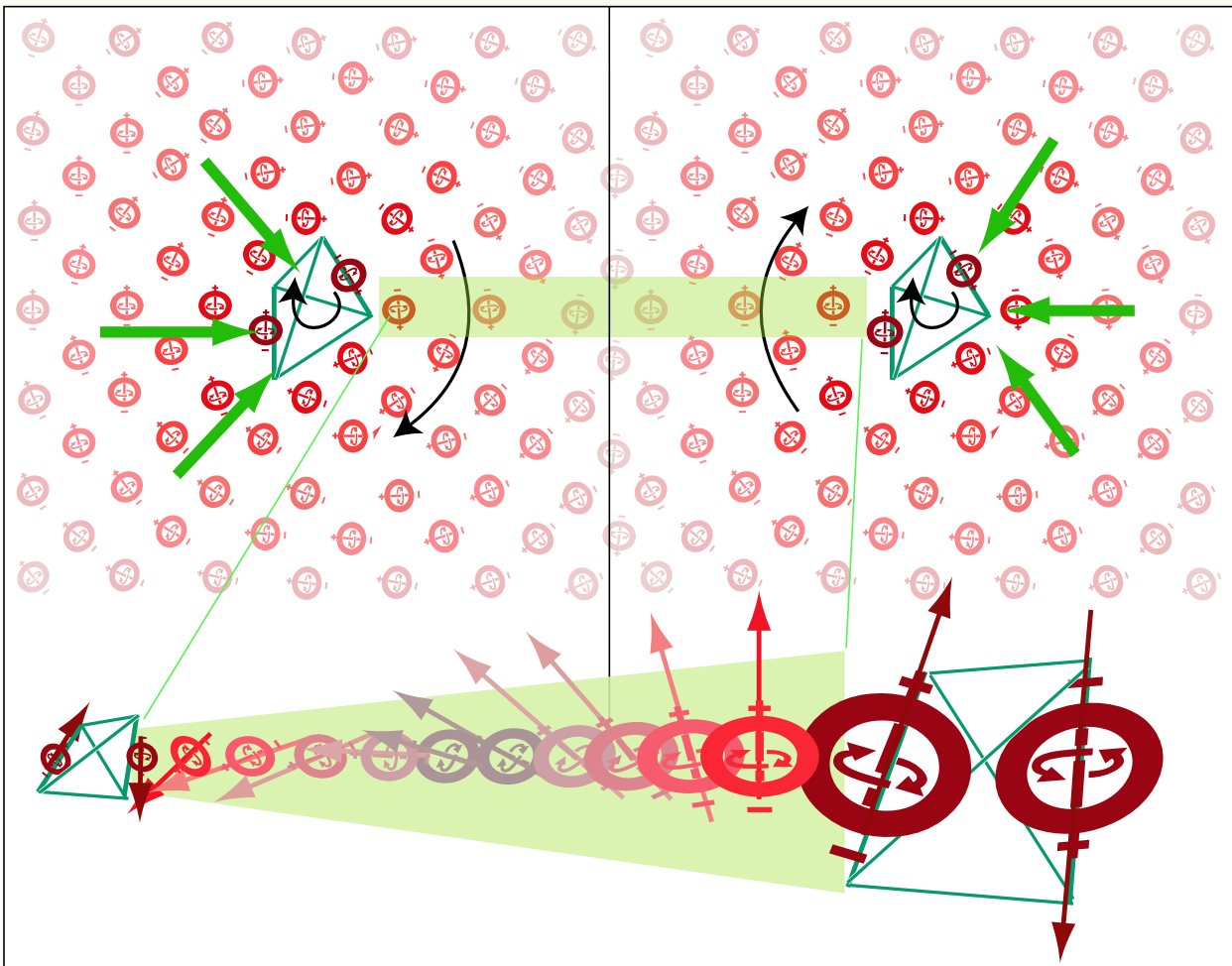


FIG. 8 Gravitational interaction between two particles. The gravitational potential (energy density due to a node's angular momentum) surrounding each particle is illustrated by shades of red. Gravitational force is due to the uncoiling of the twisting pattern of node axes in the intervening space (shaded green) causing node 'pressure' or mutual repulsion (green arrows) to transfer the locked particle patterns closer together. The black arrows indicate the rotation sense of the nodes (each in its place).

That is why two or more nodes locked into an elementary particle-like state of (+-), (- +) pole proximity thus contain the accumulated energy of pattern of nodes tessellating a hemispherical surface of half the nodes of the universe FIG.7. (GR) in (BU) is greatly simplified and reduces to the classical effects of node potential (Φ) or density, acting like an optical refractive index gradient. The bending of light in a gravitational field is then readily explained as the curvature of the streamline (i.e. radial acceleration) (FIG 3c.)



- 5- The gravitational force is the result of the uncoiling of a spring-like helical twisting of nodes along lines joining two particles as in (FIG. 8).
- 6- Forward momentum applied to matter causes the node pattern to compress before it starts moving, and Doppler shifts in signals to a distant observer of the motion cause Lorentz length contraction.
- 7- Motion is not simple as it is in (SR) or in classical physics. In (BU) it is the result of a complex process similar to the self-convolution of a soliton⁴⁰ whereby a particle's node axes rotate as a group and the locked nodes' polyhedral pattern is transferred accordingly without changing its shape, as in (FIG. 5).

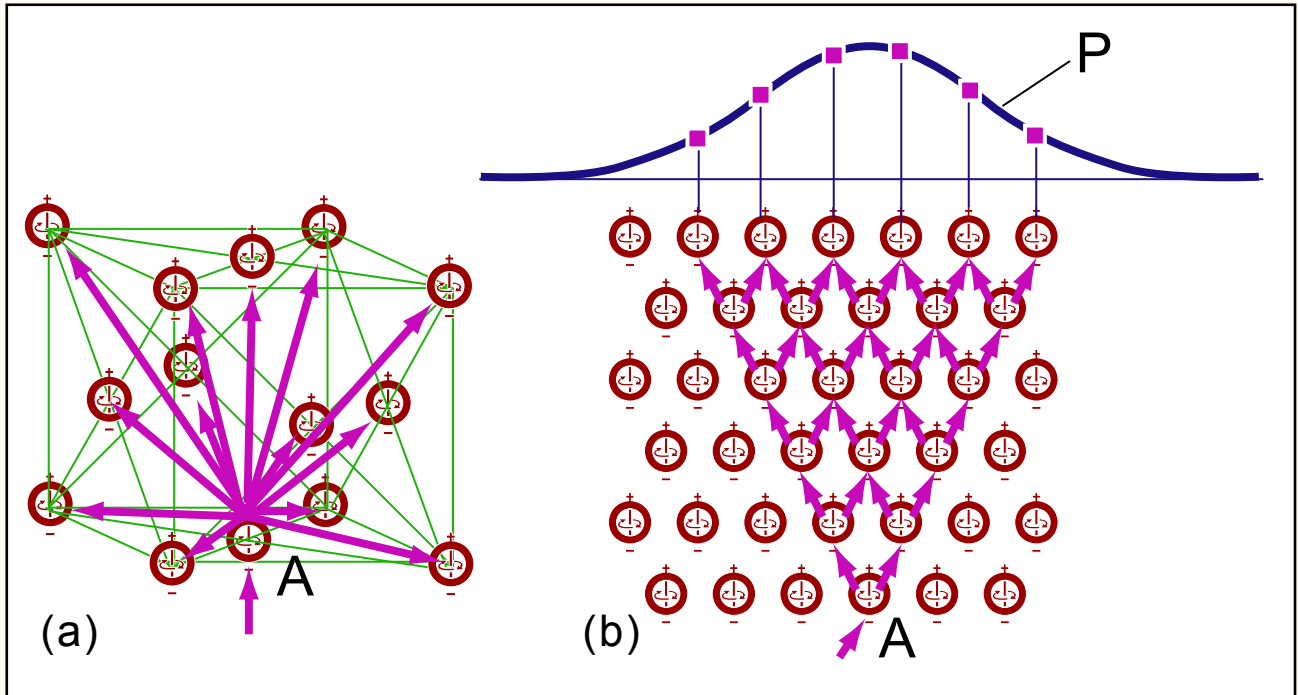


FIG. 9 A discrete Schrödinger equation would describe the wave-like diffusion of energy between nodes, each with its own phase factor, creating a normal distribution resembling probability. (a) In an actual 3D FCC lattice momentum arriving at a node A is transferred to 13 neighboring nodes. (b) In a 2D lattice the energy from A is transferred as a binomial distribution, so that the energy levels of the top row of nodes lie on a probabilistic curve P.

To answer <A/D?>, the universe is a combination of analog effects (node rotation is continuous) and digital action between discrete nodes, and in discrete units of (h). Would possible background dimensions containing the nodes be digital or analog? This is definitely outside the scope of this paper, and of this universe.





*** Biographical Note:**

Vladimir F. Tamari studied physics and then art at the American University of Beirut where he was inspired by a lecture given by Buckminster Fuller⁴¹ and by his encouraging words during a chat afterwards (around 1960). In the following years he invented and built 3D drawing instruments⁴². In the 1980's he became a member of the Optical Society of America in order to keep up with modern developments in the field. He invented and experimentally proved *Calibrated Digital Imaging Systems*⁴³ (1982) a new analog-digital system to allow imaging with arbitrary instruments and through severely distorted media using *a priori* data about the instrument and medium. His research and experimentation into methods to cancel diffraction effects in order to achieve super-resolution telescopes, led to *The Cancellation of Diffraction in Wave Fields*⁴⁴ (1987), proposing a Streamline Diffraction Theory (SDT) and getting US patents^{45 46} for its applications. The resulting insights about energy transfer in the severely curved streamlines of an electromagnetic dipole suggested they may be the geodesics of a miniature gravitational field, whose electric vectors also exhibits a probabilistic distribution normal to the axis. His *United Dipole Field*⁴⁷ (1993) was generalized into *Beautiful Universe: Towards Reconstructing Physics From New First Principles*⁴⁸ (2005) the unified theory referred to here. An artist working in watercolors, he is also an inventor, a graphic designer and a typographer of Arabic fonts. He has lived in Tokyo for the past 40 years.

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