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SUPERSTRING INTERACTIONS AND COMPUTATION

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ABSTRACT. The superstring is a generalized nested fractal sequence of superstrings where the first term is a closed helical loop like a lady's spring bracelet. It has a toroidal flux, a superstring, traveling through the helix at the speed of 7×10^{22} cm/sec, a constant of nature. The energy of each cycle is the Planck's constant $h = 6.64 \times 10^{-34}$ J. Scooped up by basic cosmic wave it flattens and becomes rapid oscillation due to dark viscosity; it becomes a photon when it breaks away from its loop. With ambiguity of large and small number computation of its number of cycles is impossible, only energy density using the generalized integral. Primal interaction is responsible for formation of coupled prima including the nucleus of the atom as well as formation of atoms and molecules and cosmological vortices. Quantum algebra computes the charge of coupled prima and solution of Hubble's law yields radial expansion rate and acceleration of our universe.

1 INTRODUCTION

The discovery of the superstring, basic constituent of matter, was crucial for the solution of the gravitational n-body problem using the methodology of qualitative modeling that explains nature in terms of its laws [5]. We state the natural laws directly involved in its discovery [4].

Energy Conservation. *In any physical system and its interaction, the sum of kinetic and latent energy is constant, gain of energy is maximal and loss of energy minimal.*

Energy Conservation Equivalence. *Energy conservation has many expressions or forms: order, symmetry, economy, least action, optimality, efficiency, stability, self-similarity (fractal),coherence, resonance, quantization, synchronization, smoothness, uniformity, motion-symmetry balance, non-redundancy, non-extravagance, evolution to infinitesimal configuration, helical and related configuration such as circular, helical, spiral and sinusoidal and, in biology, genetic encoding of characteristics, reproduction and order in diversity and complexity of functions, configuration and capability.*

Existence of Two Fundamental States of Matter. *There exist two fundamental states of matter: visible and dark; the former is directly observable, the latter is not.*

Flux-Low-Pressure Complementarity. *Low pressure sucks matter around it and the initial chaotic rush of dark matter towards low pressure stabilizes into local or global coherent flux; conversely, coherent flux induces low pressure around it.*

Existence of Basic Constituent of Matter and its Generalized Nested Fractal Structure. *The basic constituent of dark matter is the superstring. It is a helical loop and nested fractal sequence of superstrings or toroidal fluxes, with itself as first term; each toroidal flux in the sequence is a superstring having toroidal flux, a superstring, traveling at speed beyond that of light along its cycles, etc.; each superstring except the first, is contained in and self-similar to the preceding term in structure, behavior and properties.*

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Flux Compatibility. *Two prima of opposite toroidal flux spins attract at their equators but repel at their poles; otherwise, they repel at their equators but attract at their poles. Two prima of same toroidal flux spin connect equatorially only through a primum of opposite toroidal flux spin between them called connector.*

The key requirement that finally pinned down the structure of the superstring is its indestructibility; otherwise, our universe would have collapsed a long time ago. The actual derivation of the structure of superstring as generalized nested fractal circular helical loop is provided by [6]. That there is only one basic constituent of matter follows from the other requirement that every physical system be reducible to it.

The dark to visible matter conversion of the superstring is given by this natural law.

Superstring Dark-to-Visible-Matter Conversion. *When suitable shock wave hits a semi-agitated superstring one of these occurs: (a) the outer superstring breaks, its flux torus remaining non-agitated superstring; (b) a segment bulges into a primum, unit of visible matter.*

2 THE PRIMUM AND PHOTON

In cylindrical coordinates the primum has the equation $x = t$, $y(t) = \beta(\sin n\pi t)(\cos^m k\pi t)$, $\theta = n\pi t$, $t \in [-1/k, 1/k]$, n, m, k, integers, $n >> k$, m even (n much larger than k) which means that the first factor of y(t) is a rapid oscillation and since this is in cylindrical coordinates, y(t) is rotated into a rapid spiral about the x-axis. Cycle energy of the spiral is Planck's constant $h = 6.64\times10^{-34}$ J [3]. Scooped up and carried by cosmic wave, its cycles flatten to rapid oscillation, $z = 0$, $x = t$, $y(t) = \beta(\sin n\pi t)(\cos^m k\pi t)$ due to dark viscosity. It becomes photon, $z = 0$, $y(t) = \beta(\sin n\pi t)(\cos^m k\pi t)$, when it breaks off from loop; energy of one full cycle of the primum or one full arc of photon is h; its toroidal flux speed: 7×10^{22} cm/sec [1].

Since the energy of the photon is known, it appears that we can divide it by 6.64×10^{-34} to find the number of its oscillations or the number of cycles the primum has. Unfortunately, we cannot because of the ambiguity of large and small numbers. Dividing any number by the small number 6.64×10^{-34} is extremely inaccurate. Therefore, we compute instead the cross-sectional energy density distribution of rapid oscillation within photon, i.e., within its envelope given by $y(t) = \cos^m k\pi t$ in one period, $t \in [-1/\pi k, 1/\pi k]$ since m is even. Since we cannot do actual computation for the same reason we approximate the energy density by the probability distribution on the set-valued function $y(x) = \lim \sin 1/(x-s)$, as $s \to x^+$, which is uniform in the interval $[-2/\pi k, 2/\pi k]$. Therefore we need only calculate its probability distribution at the origin and find the expectation (weighted average). Then we turn to the rapid oscillation again, find its probability distribution on one sweep of its arc from 0 to $1/n\pi$, denoted by C, and its expectation and use the latter to approximate the expectation of the set valued function at the origin. The expectation is the projection of the expectation of that one sweep of the arc C of the rapid oscillation.

We need some physical mathematics, i.e., mathematics derived from physical principle [10], in this case a certain form of the Heisenenberg principle [8,12], the complementarity of speed and existence. We divide the interval [0,1] into the non-overlapping subintervals [dy,y+dy) (from here on we assume that the point interval y = 1 is included in the subdivision). We ask: what is the probability that the projection of the point P in arc C lies outside the subinterval [y,y+dy)? By the oscillation probability principle (a form of the Heisenberg uncertainty principle) [7] that says this probability is proportional to the speed of the projection of P, i.e., the derivative of dq/dw (instead of dy/dw, where w is a dummy variable for purposes of integration). We drop the proportionality constant since it will be absorbed by the normalizing constant to the probability distribution later, anyway.

We compute the probability on a half arc of the rapid oscillation,

$$y(t) = \sin\pi nt, \tag{1}$$

Differentiating (1),

$$dq/dw = \pi n\cos\pi nw dw,\ dp/dw = (1 - \pi n\cos\pi nw)dw, \tag{2}$$

where w is the dummy variable for integration. To normalize dp/dw we note that the pre-image of the projection of the point P in the vertical interval at the origin lies in the interval [0,1/4n]. We divide the second equation of (2) by the integral,

$$\begin{aligned}\int_{[0,1/4n]} (1 - \pi n\cos\pi nw)dw &= (w - \sin\pi nw)|_{[0,1/4n]} \\ &= -1/4n + \sin\pi/4 \approx (\sqrt{2})/2,\end{aligned} \tag{3}$$

The normalized probability distribution is given by,

$$dp/dw = (\sqrt{2})(1 - \pi n\sin\pi nw)dw. \tag{4}$$

Energy conservation requires that the distribution of energy be uniform among the arcs (or the cycles in the case of the primum) regardless of arc length or cycle length [4]. Therefore, the energy density along the full length of the photon is also uniform. Let σ be the energy density in appropriate units along the photon's axis. We find the generalized integral in the vertical interval [0,1] and the ordinary integral along the full length of the photon to find its total energy. Moreover, since the magnitude m only affects the roundness of the envelope at its crest and not significantly the area under it, we replace m by 2. Note, further, that our computation covers one fourth of the energy of the photon. Using the generalized integral [7] we compute the total energy.

$$\begin{aligned}\text{Total energy of photon} &= (4\sigma\sqrt{2})\int_{[0,1/4\pi k]}\int_{[0,1/4n]} \sin\pi nw(1 - \pi n\sin\pi nw)\cos^2\pi kx dwdx \\ &= (4\beta\sigma\sqrt{2})\int_{[0,1/4\pi k]}\int_{[0,1/4n]} (\sin\pi nw - \pi n\sin^2\pi nw)\cos^2\pi kx\, dwdx \\ &= (4\beta\sigma\sqrt{2}) \int_{[0,1/4\pi k]} (-(1/\pi n)\cos\pi nw \cos^2\pi kx)dx\Big|_{[0,1/4n]} \\ &\quad - (4\beta\sigma\sqrt{2}) \int_{[0,1/4\pi k]} (w/2 - (1/4) \sin 2\pi nw)C)dx\Big|_{[0,1/4n]} \\ &= (4\beta\sigma\sqrt{2})\int_{[0,1/4\pi k]} ((1/\pi n)\cos(\pi/4) \cos^2\pi kx)dx \\ &\quad - (4\beta\sigma\sqrt{2})\int_{[0,1/4\pi k]} (\pi/8) \cos^2\pi\gamma x)dx \\ &\quad + (4\beta\sigma\sqrt{2})\int_{[0,1/4\pi k]} (1/2)(\sqrt{2}/2)^2) \cos^2\pi kx)dx \\ &= (4\beta\sigma\sqrt{2}) \int_{[0,1/4\pi k]} (1/2\pi n + (\pi/8 - 1/4))dx \\ &\approx 5.64(\int_{[0,1/4\pi k]} 0.14dx = 0.79/k\ \text{J}.\end{aligned} \tag{5}$$

The order of magnitude of n/2 or the number of cycles is 10^{34}. The integer k is also large, since the length of the photon is the period of $\cos^2\pi kx$ which is π/k.

This can be checked with the known energy of the photon. From this value we can compute the numerical energy distribution of the photon. We can similarly compute the energy of a primum by considering the uniform energy density of its flattened projection to be concentrated on its envelope, calculating the sum along the full length of its profile and taking the full rotation of the latter suitably to find the total energy of the primum. Note that the total energy of the photon equals the total energy of the primum it comes from where the cycles convert to the arcs of the photon as rapid oscillation.

3 PRIMAL INTERACTION

Primal interaction is governed by the flux-low-pressure complementarity and flux compatibility laws.

The proton consists of two positive quarks joined by a negative quark at their equators on account of flux compatibility (graphics in [3]). Energy conservation requires that their axis be coplanar [5], its charge 2/3 – 1/3 + 1/3 = +1. This means that there is a net coherent vortex flux around the cluster. By flux compatibility the electron can attach itself to a positive quark of the proton at any point but energy conservation, energy conservation equivalence and optimality require it attaches itself between them beside the negative quark as the most stable position but pushes the negative quark a bit by flux compatibility so that their centers viewed from the north pole form the vertices of a quadrilateral. In its interior are the coherent vortex fluxes of the positive quarks, negative quark and electron that make it a region of low pressure or depression. By flux-low-pressure complementarity its interior sucks neutral primum around it since charged primum is repelled by primum of the same charge already in the coupling. Therefore, only suitably light neutral primum fits in and that is the neutrino. Thus, we have just composed the neutron consisting of a proton, electron and neutrino. Its charge is: +2/3 – 1/3 + 2/3 – 1 + 0 = 0, i.e., neutral, and there is no net coherent vortex flux around it. this computation of charge of coupled prima is called quantum algebra. The vortex flux of a coupled primum is also discular for the same reason as the simple primum's is.

As noted above simple primum is modelled qualitatively and computationally by the helix, $x = t$, $r(t) = \alpha(\sin n\pi t)(\cos^m k\pi t)$, $\theta = n\pi t$, $-1/k \leq t \leq 1/k$, n, m, k, integers, $n >> k$, m even. Cycle energy (due to motion of toroidal flux) is Planck's constant $h = 6.64 \times 10^{-34}$ **J**. When a primum becomes a photon the latter is stable only when its forward flux is equal to the speed of the carrier wave which is the speed of light in vacuum, $c = 3\times10^{10}$ cm/sec; otherwise, it leaves the carrier and disintegrates its toroidal flux remaining in dark matter. This is the reason it has no rest mass; it has mass since it is matter.

Since the masses of the neutron, proton and electron are known [11] we can compute the mass of the neutrino.

$$\begin{array}{ll} \text{Neutron:} & 1.674 \times 10^{-27}\text{ kg} \\ \text{Proton:} & 1.672 \times 10^{-27}\text{ kg} \\ \text{Electron:} & 9.611 \times 10^{-31}\text{ kg.} \end{array} \tag{6}$$

Converting to atomic mass unit (amu) we obtain their masses:

$$\begin{array}{ll} \text{Neutron:} & 1.0087\text{ amu} \\ \text{Proton:} & 1.0073\text{ amu} \\ \text{Electron:} & 5.486 \times 10^{-8}\text{ amu.} \end{array} \tag{7}$$

$$\eta = 8.5 \times 10^{-8}\text{ amu or 1.55 times electron mass.} \tag{8}$$

It was thought for a long time that the neutrino had no mass which is impossible since it is matter but still it is a subject of hot pursuit [13].

4 MACRO GRAVITY

Macro gravity is the dynamics of global vortex flux of superstrings, i.e., cosmological vortices; quantum gravity is the local dynamics of primal induced vortex fluxes of superstrings. They are dual to each other. The unit physical system of quantum gravity is the atom since it has all the interactions of quantum gravity; its dual is the galaxy that has also the dynamics of macro gravity. Both the atom and the galaxy are generalized nested fractal sequences of superstrings. In macro gravity the first term of the fractal sequences is the super…super galaxy, our universe. We provide some computation on our universe [6].

Hubble's law says: the rate of recession of any galaxy at distance s from Earth is:

$$ds/dt = \rho s, \tag{9}$$

where $\rho = 1.7\times10^{-2}$ /km distance of the receding galaxy. For convenience, we measure distance S along a great circle in the spherical dark halo of our universe. Then,

$$dS/dt = \rho S. \tag{10}$$

Since this discovery the estimate of the age of our universe increased from the original 8 billion to the present 14.7 billion and there is talk of raising it to 20 billion. Each time an older star is discovered the estimate is adjusted to accommodate it. This star-chasing game is based on the wrong premise that only our universe exists. In fact, there are others and the evidences are quite strong. One is the presence of galaxy clusters traversing our universe [14] and another is collision of galaxies from different directions [15]. Galaxies in our universe travel along outward radial trajectories and cannot collide among themselves. Still another is the discovery of stars in the Milky Way older than the Big Bang [18].

Therefore, we stick to the original estimate of 8 billion to solve (4) and find the radius r as function of t. Since $dS/dt = 2\pi dr/dt$ and (10) is independent of the distance between us and the other galaxy it holds when S = r. Then,

$$2\pi dr/dt = \rho r \text{ or } dr/r = (\rho/2\pi)dt. \tag{11}$$

Solving r, reckoning time from the Big Bang with light year and 1 billion years as units,

$$r(t) = 10^{10}e^{(\rho/2\pi)(t-8)} \text{ light years, } r'(t) = (\rho/2\pi)10^{10}e^{\rho/2\pi\,(t-8)} \text{ light years/billion year,}$$
$$r''(t) = (\rho/2\pi)^2 10^{10}e^{\rho/2\pi\,(t-8)} \text{ light years /(billion year)}^2. \tag{12}$$

Using standard units we have, at t = 8,

$$r(8) = 3.2\times10^{22} \text{ km, } r'(8) = 840 \text{ km/sec, } r''(8) = 1.7\times10^{-2} \text{ km/secsec.} \tag{13}$$

Since $r'' > 0$, our universe is on the young phase of its cycle, its power of spin still rising. This acceleration is considerable and the rate of outward radial flight of the galaxies will surpass the speed of light soon [17]. The value of ρ is based on direct observation and analysis of Doppler effect on spectrum of light coming from a receding source.

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