A Remarkable Quantum Mechanical Disccovery

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Abstract
Evidence is presented in support of the hypothesis that Diaz and Rowlands' remarkable discovery of a universal grammar for semantic quantum mechanical mathematical language description, is a candidate for 'alternative (a)' in Leggett's incisive Einstein's Legacy viewpoint in *Science*, 307, 2005, 871-872 on 'The Quantum Measurement (QM) Problem'. 'Alternative (a)' says that 'QM is the complete truth about the physical world (in the sense that it will always give reliable predictions concerning the nature of experiments) at all levels and describes an external reality'.
Keywords: quantum measurement problem, quantum Carnot engine, a quantum measurement evolutionary cosmology, Standard Model elementary particle physics, general relativity

1 Introduction

Success in science is measured by agreement between the predictions of the particular mathematical theory language description used and experiment, and the language's interdisciplinary breadth. Syntactic correctness of the language is thus a necessary but not necessarily sufficient condition. It may only guarantee a combinatorial explosion of possible correct solutions, as now appears to be the case in string theory according to the admission of one of its originators, Susskind.

However, in an entirely novel, first principles, semiotic approach to mathematical language description, Diaz and Rowlands (D&R) have demonstrated [1], by generalizing the concept of the computational rewrite system, that there exists a semantic mathematical language description with a universal grammar, namely nilpotent quantum mechanics (NQM), governed by the nilpotent generalization of Dirac's famous quantum mechanical D(N)

$$(\mp \boldsymbol{k}\partial/\partial t \pm \boldsymbol{i}\nabla + j\boldsymbol{m})(\pm \boldsymbol{ik}E \pm \boldsymbol{i}\mathbf{p} + j\boldsymbol{m})\, exp\, i(-Et + \mathbf{p}.\mathbf{r}) = 0 \qquad (1)$$

where E, $\mathbf{p}$, m, t and $\mathbf{r}$ are respectively energy, momentum, mass, time, space and the symbols $\pm 1, \pm i, \pm \boldsymbol{i}, \pm \boldsymbol{j}, \pm \boldsymbol{k}, \pm \mathbf{i}, \pm \mathbf{j}, \pm \mathbf{k}$, are used to represent the respective units required by the scalar, pseudo-scalar, quaternion and multivariate vector groups. That is, D(N) specifies the rewrite system's computational order code.

This remarkable discovery, thus, potentially offers an entirely novel mathematical language means of a semantics with a universal grammar, NQM, to bring about the desired agreement between theory and experiment, where computation/quantum measurement consists of an input/quantum preparation followed by an output. For the

extensive work of Rowlands, Cullerne and others [2] in predicting the properties of NQM governed by equation (1), not only shows:-

a) that the spontaneous symmetry breaking of equation (1) (from now on to be referred to simply as the Nilpotent Dirac Equation) describes the simultaneous complementary emergence of 3+1 relativistic space-time and the quantizations of the strong, weak, and electromagnetic force of elementary particle physics, from 'nothing' their empty state, but also

b) that these quantizations, including both spin and massive particles [3], see equations (3) below, are in excellent agreement experimentally with those of Standard Model elementary particle physics, so that they constitute the entire set of sources and sinks of the 3+1 relativistic space-time field, which as derived from D(N) is thus a quantum phenomenon.

This is to say that this mathematical language description of 3+1 relativistic space-time emergence, furnishes a quantum theoretical explanation of 3+1 relativistic space-time's existence as a fundamental quantum property of the physical world, something that string theory has long been expected to describe but which it has yet to do.

Furthermore this empty state can be taken as a boundary condition – essential to the correct solution of any problem – for the quantum system that D(N)'s computational order code governs. This is in agreement with the requirement of nilpotence, that the quantizations, equations (3), also specify corresponding phases, so that these are the gauge invariant phases of the quantum mechanical state vector of the system.

This empty state of 3+1 relativistic space-time and matter, taken as the boundary condition for NQM, thus has the full spatial and temporal quantum coherence necessary for holography in confirmation of the fact that a quantum holographic mechanism is specified in NQM by

$$(\pm ikE \pm i\mathbf{p} + jm) \text{ which has a Fourier transform } (\pm ikt \pm i\mathbf{r} + j\tau) \qquad (2)$$

where these nilpotent operators, equivalent respectively to amplitude and phase, define the action of two sources of equivalent independent information, $\mathbf{p}$ or $\mathbf{r}$, and E or t, relative respectively to the proper energy/rest mass (m) or equivalently the proper time (τ), either or both of which can be regarded as fixed/fixing a reference frame. This nilpotent structure thus admits 3-dimensionality, vector $\mathbf{r}$, operating as a single unit, as well as other multi-dimensionalities (1-D, 3-D, 4-D, 5-D, 6-D, 8-D, 10-D and 11-D), depending on the perspective applied to the Clifford algebra of the rewrite language description.

However, in one perspective, these become 2-D, so that the minimum determining information, $\mathbf{r}$ and t in (2) is in agreement with the holographic principle and thermodynamics through the famous concept of a bounding 'area' [4] which determines the relation between a system and the rest of the universe as a unit of thermodynamic information. The 'area' realized within the NQM nilpotent structure is that of the complex plane, involving $\mathbf{r}$ and t, which determines the nilpotent relation between the fermion state and the rest of the universe. It can be projected as a real area, because the fundamental dualities in the rewrite system allow the exchange of information about 2 spatial dimensions for 2 dimensions of space and time; and therefore, because $\mathbf{r}$ can also

be considered as a 3-D quantity in its own right, this NQM minimum rewrite description is that of a 4-D boundary to a 5-D quantum system/universe.

Equations (3) the table of the nilpotents X_i of D(N) where $X_i^2 = 0$ for $X_i \neq 0$

Baryons (spin 3/2):

$$\begin{array}{c} \\ inertial \\ strong \\ weak \\ electric \end{array} \begin{pmatrix} ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \end{pmatrix} \begin{pmatrix} ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \\ ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \end{pmatrix} \begin{pmatrix} ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \\ ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \end{pmatrix}$$

Baryons (spin ½):

$$\begin{array}{c} \\ inertial \\ strong \\ weak \\ electric \end{array} \begin{pmatrix} ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \end{pmatrix} \begin{pmatrix} ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \\ ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \end{pmatrix} \begin{pmatrix} ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \\ ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_3 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_2 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \end{pmatrix}$$

Leptons:

$$\begin{array}{c} \\ inertial \\ strong \\ weak \\ electric \end{array} \begin{pmatrix} ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ -ikE \pm i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \\ -ikE \mp i\boldsymbol{\sigma}.\mathbf{p}_1 + jm \end{pmatrix}$$

It is also known [5,6] that the bosonic/Lie partition of the NQM state space (complementary to the fermionic/Clifford partition) is governed by the 3 dimensional (3D) nilpotent Heisenberg Lie group description G(N), where, as was known to Weyl, G(N)'s nilpotent Lie algebra Y, $Y \neq 0$; $Y^2 = 0$, is the simplest such Lie algebra and defines the 'Heisenberg uncertainty'. Remarkably therefore, in NQM, 'Heisenberg uncertainty' itself is an actual means by which to compute, for the Lie nature of G(N) guarantees the existence of a dual G`(N) [5,6] with Lie differentiable exponential mappings with differentiable inverses, enabling the description, for example, of the control of the measurement process and the parameterization of (nuclear) Magnetic Resonance Imaging (MRI) machines [7], where holographic 2D/3D image encoding and decoding is effected by fast symplectic Fourier transform action, synthetic aperture radars (SARs), etc.

Such MRI imaging and microscopy [7], SARs [5], etc. thus provide experimental support that NQM semantic mathematical language description includes a universal QM theory of holographic 2D/3Dimage processing [7], that (2) would lead us to expect. This, taken together with the experimental support that the basic semantic ontology of the D(N), corresponds to the fundamental elementary particle structures of the 3+1 relativistic space time physical world, from which, as far as it is known experimentally, all other more complex physical/chemical/ biochemical structures are derived by means

of the forces, whose equations (3) specify, point to the testable hypothesis, that 'nilpotent quantum mechanical language description provides, because of its universal grammar, the semantic descriptive basis for a theory of everything in agreement with experiment, such that in this NQM system, the quantum state vector is that of the universe itself, where should any further prediction of NQM semantic language capabilities, at all, fail to correspond with experiment, the hypothesis will be invalidated."

2 An overview of the generalised nilpotent rewrite system

The nilpotent universal computational rewrite system (NUCRS) differs from traditional rewrite systems, of computational semantic language description with a fixed or finite alphabet, in that the rewrite rules allow new symbols to be added to the initial alphabet. (Examples of conventional rewrite systems are to be found at http://algorithmicbotany.org/papers/#abop, where the finite alphabet semantics correspond to geometric rules so as to give very lifelike pictures matching those in botany, e.g. a sunflower.) In fact D&R start with just one symbol representing 'nothing' and two fundamental rules (or dual aspects of a single rule): *create*, a process which adds new symbols, and *conserve*, a process that examines the effect of any new symbol on those that currently exist to ensure 'a zero sum' [1] again. In this way at each step a new sub-alphabet of an infinite universal alphabet is created. However the system may also be implemented in an iterative way, so that a sequence of mathematical properties is required of the emerging sub-alphabets. D&R show that one such sequential iterative path proceeds from nothing (as specified by the mathematical condition nilpotent) through conjugation, complexification, and dimensionalization to a stage in which no fundamentally new symbol is needed. At this point the alphabet is congruent with the nilpotent generalization of Dirac's famous quantum mechanical equation (1), showing that it defines the quantum mechanical 'machine order code' for all further (universal) computation corresponding to the infinite universal alphabet. The property of the universal nilpotent rewrite system that a new symbol can stand for itself, a sub-alphabet or the infinite universal alphabet, allows it to rewrite itself, so as to enable it to describe the ontological structure at a higher (hierarchical) level in terms of those at lower levels, beginning with the fundamental level described by equations (3). This rewrite system with its nilpotent bootstrap methodology from 'nothing/its empty state' thus defines the requirement for universal quantum computation to constitute a semantic model of computation with a universal grammar. It is also significant that, though the universal rewrite system generates both number systems and algebras, it is not confined to these systems, and does not depend on the pre-existence of numerical or algebraic concepts, or any of the ideas of set theory, and the zero is not confined to being that of the empty set. The mathematical structure generated derives rationals from reals, not reals from rationals; and shows that complexification logically precedes discrete numbering, a result that cannot be derived from any form of set theory.

3 The Remarkable Discovery's Scientific Perspective

The above evidence and further evidence to be provided later in this paper in support of the proposed hypothesis that nilpotent quantum mechanical language description constitutes that of a theory of everything, thus further advances D&R's claim [1] that their demonstration of a generalization of the computational rewrite concept and its resulting conclusion, can be taken as a new fundamental computational foundation for both quantum mechanical and mathematical language description, where this claim and the hypothesis are consistent with the following scientific perspective :-

a) that 'In science, Nature sets the rules, but it must never be forgotten, that it is only because life has exploited these rules successfully for billions of years to our evolutionary advantage, that human brains are able to understand them.'

b) that the processes of semantic computation as described by D&R (including their demonstration itself) are fundamentally quantum physical in nature; an accepted conclusion about the nature of universal computation already reached independently by Deutsch [8] and Feynman [9].

c) that digital computation, which Deutsch [8] has shown quantum computation includes, constitutes a universal regime of rules for syntactical but not yet semantically correct computation, so as to explain why the required semantic basis for any digital computation/algorithms must in general be effected through the agency of the human brain. For from the known facts of its working, in particular its human language capabilities, the human brain is almost certainly a universal semantic computational machine. The remarkable discovery thus marks a clear distinction between human and artificial intelligence, and would explain why the architecture of the human brain is so different from its digital counterpart.

d) that there other senses in which digital computation is incomplete. For, if described simply in terms of universal logical primitive NAND, it lacks:-

i) as Feynman [9a] points out, the additional 'physical' primitives like those of the unit wire and of signal exchange, such descriptions of digital computation require if they are to be physical implemented and executed; and

ii) that descriptions of digital algorithms can have no meaning unless, as Wheeler has pointed out [10], there exists some actual physical means by which they can be carried out/executed,

e) that semantic computation explains why, despite a digital computer's simplicity, there are no naturally evolved species with nervous systems based on digital architectures. This preference of nature can be attributed to the fact that physical trajectories/systems are known to naturally follow geodesics and principles, like that of least action (as indeed does quantum mechanics in Feynman's sum over histories formulation) and so will most likely lead to any natural computation/measurement taking place in a minimum number of computational steps, i.e. optimally [9b] ,

f) that of the requirement, as cited by Deutsch [8], that all valid computation must be canonically labelled, which is satisfied in NQM as governed by D(N), because the Pauli exclusion principle applies to NQM's fermionic states, so as to be in agreement with Wittgenstein's (semantic) principle [11] that there is necessarily only one proposition

for each fact that answers to it, and that the sense of a proposition cannot be expressed except by repeating it,

g) that, contrary to the Platonic assumption, mathematical language description is just another form of natural semantic language capability, which derives its origin from the semantic computational capabilities of NQM, but where natural languages have only now made their evolutionary appearance:-

i) because natural language necessitates a nervous system and biological brain of the size, power and complexity the human brain, which the facts show has never existed until the present era,

ii) because of the enhanced evolutionary advantage that semiotic/semantic language communication and understanding of the world including mathematics, now demonstrably offer for the survival of the human species, at the present stage of evolution, and

iii) where in the foundation of any natural language, a necessary grammar for semantics in addition to syntax, provides what is known in human communication as its 'commonsense' [12],

h) that mathematics itself is indeed a semantic language with a grammar, is supported by John Conway's 1976 generation of the surreal numbers [13,14]. For this results in a non-standard mathematical analysis over the surreal number fields [15] as an alternative to that of the more usually accepted Zermelo-Fraenkel set theory, and Conway's generation can now, with hindsight, be recognized as constituting a computational rewrite methodology, which

i) in agreement with D&R [1] has two fundamental productions (see overview) for the concept of order intrinsic to number, which Conway calls Left L and Right R,

ii) begins from the symbol for the empty state of no numbers, assigning a value to each number symbol so as to generate a unique birthordering of all the numbers great and small including the transfinite and the infinitesimal, where this birthordering is the birthorder surreal number field automorphism, and

iii) also treats the case where the order actions of Left and Right are no longer distinguished, so as to show that this new birthordering is that of the simplest mathematical field of all the ordinal numbers and so admits all the properties of number.

These rewrite perspectives therefore indicate that both theoretical physics and mathematics, grounded in NQM quantum physical process action, are single, possibly equivalent, bodies of human linguistic knowledge emergent from the human brain, a quantum physical semantic machine, as the evolutionary result of the semantic natural physical law that is D&R's remarkable discovery, so this law's semantic mathematical language description would be expected, in addition to correct syntax, to provide the description of such properties as:-

i) a measure, metric and Hamiltonian/Lagrangian for each variable, process and system respectively described, and

ii) thermodynamic principles in relation to quantum measurement, where information is a physical resource such as entropy production, able to produce, as in MRI, real and virtual imagery of 3+1 relativistic space-time physical structures; where these images exist independently of the presence of any observer. This is the fact that natural

radiation of any kind, incidence on any object it illuminates, shows to be the case; for as is known (and can be demonstrated holographically) such incidence will, quite independently of any observer, effect local changes of the radiation's amplitude and phase, so as to capture the 3+1 relativistic space time image of the illuminated object as appropriate to the nature of the incident radiation.

4 Further Supporting Evidence

The quantum measurement process in NQM is therefore the universal semantic computational decision criterion for deciding among QM descriptions what quantum physics is, where the leading question is 'Will further NQM predictions continue to be in good accord with experimentally validated quantum physics, in the future or as has been already established in the past?'

4.1 General Relativity

From the 4-vector group description of 3+1 space time in D(N) [2], which, among other possibilities, governs both 3+1 space-time's quantum emergence and its geodesic behaviour in NQM, it follows that Einstein's legacy of both special and general relativity also holds universally in NQM (see also [2d]). This prediction is in good agreement with experimentally validated uses of general relativity, and in particular those of the cosmological models, where general relativity is widely used because the corresponding models of quantum gravity are not known. However, since general relativity is compatible with NQM semantic description, where it coexists with Heisenberg uncertainty and quantum coherence, it is necessary to explain how this is possible, when this has not generally been found quantum mechanically to be the case.

In NQM, this almost certainty follows from the fact in D(N) spontaneous symmetry breaking, 3+1 relativistic space-time and Standard Model elementary particle matter emerge as complementary fundamental quantum physical properties, where each are therefore the cause and anti-cause of the other, rather than matter and antimatter as is usually taken to be the case, so this D(N) symmetry-breaking would account for the observed asymmetry in the universe between the latter.

Also in NQM, as already pointed out, in contrast to QM, Heisenberg uncertainty is in fact the actual optimal means by which to compute, and not an obstacle to computation in QM as is usually considered to be the case. Thus, as is the case with chaotic computation, where chaos can be used to minimize the number of steps to the specified proximity of the desired result, in NQM computation, Heisenberg uncertainty performs the same role, through, as already stated, for example, Lie exponential diffeomorphic language description. Or as experimentally demonstrated [16], the optimal control of chemical reactions in a chemical soup so as to produce desired chemical output in real time, a process which formally corresponds to the solution in real time of the Schrödinger equation for the chemistry.

It is not entirely surprising therefore that the role that Heisenberg uncertainty performs in NQM in computing the 3+1 relativistic space-time trajectories of objects

does not only therefore define geodesic behaviours but the ones in agreement with those of general relativity [2d]. Furthermore as NQM behaviours include quantum coherence, NQM systems will behave quantum coherently as quantum mechanical Carnot engines [17], see below, and so always includes a component of thermodynamic behaviour, where this is governed by the phase of the quantum coherence. This factor thus needs consideration when Heisenberg uncertainty is taken into account. It says that thermodynamic considerations in NQM will almost certainly play a role in relation to NQM general relativistic behaviours as a mechanism by means of which such behaviour is quantum mechanically achieved, in contrast again to other QM models which do not usually include quantum thermodynamic considerations.

Also in NQM where the Standard Model of elementary particles constitute the entire sources and sinks of the 3+1 relativistic space-time field, no additional elementary particles such as gravitons are necessary to explain 'gravitational' 3+1 space-time effects.

4.2 Quantum Thermodynamics and Evolution

The NQM quantum universe's state vector at its initial boundary condition, the empty state of 3+1 space time and matter, is therefore defined by a single parameter the phase ϕ of its quantum coherence appropriate NQM description as pure quantum Carnot engine QCE(N) [17a]. Such a QCE(N) description differs from that of the well known classical thermodynamic Carnot engine (CCE), by the possession of quantum thermodynamic behaviour governed solely by ϕ. And ϕ as is well known, is for any quantum system arbitrary up to a fixed phase, but its relative phases are the invariant phases of its state vector. This NQM boundary condition thus defines a nilpotent quantum thermodynamic evolutionary cosmos described in terms of a single Quantum Carnot Engine QCE(N), in good agreement with the properties of the nilpotent computational rewrite system that D&R have demonstrated, where the initial nilpotent quantum preparation is the empty state of 3+1 relativistic space-time and matter and each subsequent thermodynamic measurement cycle of QCE(N) is the preparation for the next.

From the earlier fact above that this initial preparation results in emergence of the two basic phenomena, 3+1 space-time and elementary particle physics from their empty state, it can be inferred that both the Second and Third Laws of Thermodynamics will hold and that the evolutionary quantum cosmology QCE(N) described is an irreversible process, where the initial arbitary fixed phase ϕ provides the measurement standard for all subsequent measurements, and where the initial and subsequent quantum preparations account for the irreversibility [17a]

Moreover these conclusions are in agreement with previous research, including:-

a) that by Deutsch into universal quantum computation [8] that the Second and Third Laws of Thermodynamics hold, and

b) that by Berry [18] that there exists an unknown quantum mechanical system with time reversal asymmetry of which the phase space trajectories are chaotic, such that its self adjoint Hamiltonian energy function has eigenvalues/quantizations corresponding

to the imaginary parts of the non trivial zeros of the Riemann Zeta function and all lie on the line $x = ½$ if the Riemann Hypothesis is true.

That is to say that there exists a quantum coherent quantum chaotic system consisting of a single fermion state with spin = ½, where all its quantizations correspond to gauge invariant phases of its state vector so that they are imaginary and lie on the line $x = ½$, as do the ground states of those, it can be hypothesized, of the irreversible evolutionary nilpotent cosmology QCE(N) as proposed here. The Riemann Zeta function can thus be envisaged as a de Broglie pilot 'standing' wave that guides the overall evolution, in line with his vision that the principle of least action and the Second Law of Thermodynamics act in a like manner, where respectively the energy $E = h\nu$ and the entropy $S = kT$ [19]. The Zeta function's known over-riding critical role in mathematical number theory, is thus a further confirmation of D&R's claim that their remarkable discovery provides a new fundamental foundation NQM for both quantum physics and mathematics in terms of their semantic language description.

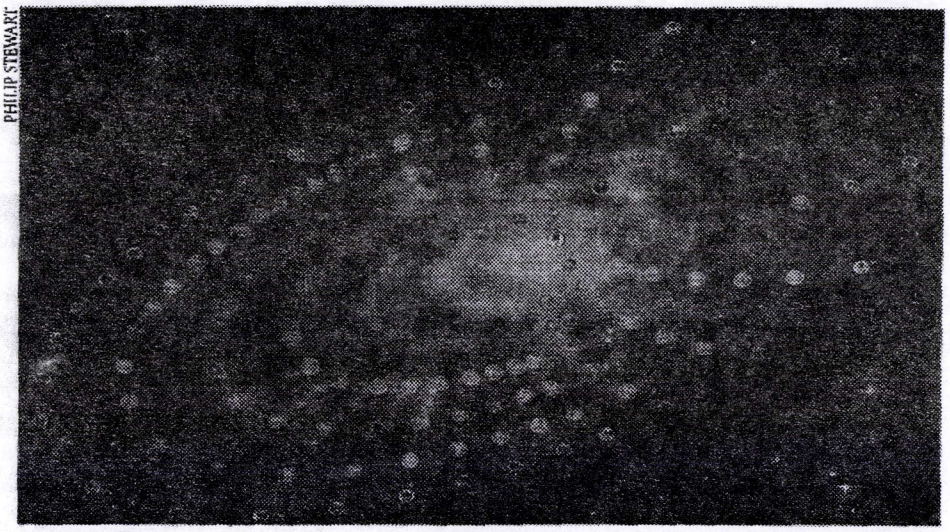

Figure 1 This new spiral presentation for the periodic table begins with neutronium, not usually considered an element (but which cosmically is as abundant as oxygen). It situates hydrogen next to carbon which chemically it most resembles. Such a spiral emphasizing the fact that the elements form a continuum, rather than a series of blocks, is in excellent accord with QCE(N) where the quantum phase ϕ follows such a time reversal asymmetric spiral behaviour. (*Illustration, courtesy of Philip Stewart.*)

Further evidence of this evolution, the nilpotent rewrite system tell us, though its computational ability to rewrite the basic descriptions for D(N), in the form of more complex 3+1 space time structures, composed of Standard Model Elementary particle matter is, confirmed by the recent publication by Stewart [20] of a galactic-like spiral presentation for the periodic table of the atoms/nuclei of the elements. This presentation is in line with their known experimental chemical properties, see Figure 1, which, as far

as is known, are explained and completely understood in terms of the four forces and particles of the NQM model. The success of this spiral presentation can thus in NQM be attributed to the above QCE(N) evolution as governed by ϕ, the phase of its quantum coherence. For such an evolution would be expected to concern the simplest unit exhibiting all the NQM forces namely neutronium/the neutron from which, in the new spiral conception of the periodic table (Figure 1), all the elements are then be envisaged as evolving as described by the D&R nilpotent universal rewrite procedure where at this level of ontological complexity the rewrite sub-alphabet concerns the two fundamental nuclear processes of fusion and fission as its production rules, see overview, and where the gaps in the spiral for larger configurations of neutronium are due to nuclear instability kicking in.

4.3 Living Systems – The RNA/DNA genetic code and the Human Brain

Thus the elementary particle matter equations (3) constituting the description of the sole sources and sinks of the 3+1 space-time (now quantum!) field, define the basic '3+1 space-time furniture' in terms of which all further descriptions, like that of the periodic table above, can be made. This is in accord with D&R's computational rewrite system description where any symbol S of its rewrite alphabet, can stand for, itself as single symbol, a sub-alphabet, and its infinite universal alphabet. That is to say, that just as the periodic table of the elements is the semantic ontology/'space-time furniture' corresponding to a subalphabet, then if the proposed hypothesis mooted here and supporting evidence [21] is correct, the RNA/DNA genetic code for life, and human natural language will both correspond in this rewrite hierarchy of alphabets, to potentially infinite universal alphabets, which describe rewrites of already existing 'space-time furniture' so that:-

i) in living systems [21,22], the RNA/DNA genetic code describes 'the biological hierarchy of the space-time furniture of living systems as governed by RNA/DNA, now a semantic/semiotic genetic code [21], and which is a D&R generalized computational rewrite methodology in its own right, where the two fundamental rewrite productions of RNA/DNE, its create and conserve operations are instantiated by the base-pairings (A = U in RNA which rewrites A = T in DNA) and G ≡ C respectively, where A, U, T, G and C are the usual biomolecular structures. For it is through these relatively fragile structures of these base pairings that the actions of the whole of information transfer throughout the biosphere takes place (including it can be mooted from [21,22] that of 3D holographical imagery), so that in NQM they are truly the cipher of life, and

ii) in the Human Brain [22b-22m], at the semantic ontological level of its biological space-time neural furniture, where human thought can now be inferred to be quantum measurement, computational input/quantum preparation followed by computational output, so that it is able to function semiotically as a neural D&R computational rewrite system, as is evidenced by its natural semantic language capabilities. And where for example in the mathematical language of category theory, the arrows of the theory, can thus be quite literally taken as formally representing 'such of human thought' so as to describe the rules which govern it.

5 Other Older Evidence in Support of Semantic Computation

This comes, from different quarters:-

a) Anticipatory Computation, the subject of a series of seven international conferences on Computing Anticipatory Systems organized by CHAOS asbl under the direction of Professor Daniel Dubois, its founder, see www.ulg.ac.be/mathgen/CHAOS. This body of research publications, see http://www.ulg.ac.be/mathgen/CHAOS/CASYS, is now recognizable with hindsight as employing computational rewrite methodology [23b,c]; a fact which says much for the Dubois's prescience in 'anticipating' this new branch of the computer science which concerns semantic computation, which he has championed for many years, through the alternate and very important concepts of chaotic computation, incursion, hyperincursion and of course computing anticipatory systems. The concept of semantic computation would provide an alternative explanation of why Dubois's concepts above are so successful, as this body of publications demonstrates, in arriving rapidly at sound computational solutions to difficult problems, and as to why recursion in the form of ordinary digital computation may fail to do this, while incursion and hyperincursion can succeed.

b) Other prescient work on semantic computation can also with hindsight be recognized to concern the 'New Computing Principle' [23d] (in which the description of the optimal design for the physical machine already incorporates a description of a Lagrangian) and the 'Theory of the Cybernetic and Intelligent Machine based Lie Commutators' [23e] (where computer input/output is represented by a categorical arrow, so as to describe such machines formally in terms of 'arrows of human mathematical thought'). Both followed from Dennis Gabor's paper 'A Universal Non-linear filter, Predictor and Simulator which optimizes itself by a Learning Process' [23f], as generalized by using the categorical formulation of 'General System Logical Theory' [23g] based on Jessel's formalization of Huygens' principle of secondary sources [23h]. These, respectively, might therefore be more appropriately named as:- the New Semantic Computing Principle, the Theory of the Semantic and Intelligent Machine .... , and General System Semantic Theory; the first of which is set out more detail in terms of the topological structures below:-

$$\textbf{(4)} \qquad G_s G_j \prod_{i=1}^{p} f_{mi}(0) = G_k G_j \prod_{i=1}^{p} f_{mi}(0) + (G_j G_k - G_k G_j)\left(\prod_{i=1}^{p} f_{mi}(0)\right)$$

(5)

$$\begin{array}{ccc} \prod_{i=1}^{p} f_{mi}(0) & \xrightarrow{\quad G_j \quad} & G_j \prod_{i=1}^{p} f_{mi}(0) = \prod_{i=1}^{p} f_{mi}(t) \\ \Big\downarrow G_k & & \Big\downarrow G_s \\ G_k \prod_{i=1}^{p} f_{mi}(0) & \xrightarrow{\quad Gj \quad} & G_s G_j \prod_{i=1}^{p} f_{mi}(0) = \prod_{i=1}^{p} f_{mi}(0) \end{array}$$

i) where the G's are topological Lie groups describing translation, rotation, Euclidian movement, affine, homographic, gauge and other topological transformations, etc., and require an equivalence relation between groups $G_k \equiv G_s$ that is represented in equations (4) and (5) where G_k and G_s are the two equivalent continuous groups, Gj is the continuous reference group and $f = (f_1, \ldots, fm_1, \ldots, fm_2, \ldots, (n$ terms)) are the computer input and output signals of a vectorial field U where $\exists$ operators $O_j(f(t))$ constitute its Lie algebra of derivations;

ii) in which the optimal design of the machine for a physical system describable by a Lagrangian is already incorporated, as it can easily be shown that the continuous groups involved are functions of this type; and

iii) where the machine's underlying architecture is that of a unified, multiple ordered, parallel, non-linear analogue computer, able to utilized physio-chemical as well as electronic mechanisms, where no quantization of the input field is necessary.

c) This new Principle is in line with J.A. Wheeler's 1986 hypothesis [10] of 'Physical Law without Law', that the physical foundations of computation constitute 'a Meaning Circuit or 'bootstrap' able to determine physical law without any prior knowledge of what that law maybe. This bootstrap arises from the fact that, while such law must be describable in algorithmic form, any such description (of the law) can have no meaning unless there exist actual physical processes by means of which to execute it (the algorithm).

Wheeler's hypothesis may be paraphrased as saying that such a semantic meaning circuit describes not only that which can be said by words but that by means of which words are said (or alternatively, in living systems as described semantically by the DNA genetic code, and where DNA is also the quantum physical means ontologically by which each living system is actually physically brought into existence). And it is a hypothesis for which D&R's demonstration of a universal semantic quantum mechanical state space NQM with its universal grammar provides a definitive solution.

d) There is also cited at http://www.bcs.org.uk/cybergroup.htm an abundance of published research cited beginning with the seminal research of Pribram [22l], for example, Brain and Perception, Holonomy and Structure in Figural Processing 1991 in support of quantum bio and neural computation, much of it based on Schempp's quantum holography [6,7] governed by the 3-dimensional nilpotent Heisenberg Lie group, as is now appropriate to describe behaviour in NQM. For a sample, see references [21,22].

e) It is also possible to identify other examples of computational rewrite systems, namely:-

i) Spencer-Brown's controversial Laws of Form,

ii) the Alternative Natural Philosophy Association's discrete model of quantum physics, called the Combinatorial Hierarchy [13].

iii) the Dirac formalization of quantum mechanics in terms of bra and ket vectors, as set out in his famous and foundational book on quantum mechanics.

6 A Remarkable Feature of the Remarkable Discovery

The key feature of the nilpotent universal computational semantic rewrite system is that each emergent symbol of its infinite universal alphabet may also stand for its universal alphabet (subject to the nilpotent closure of the previous set of symbols, so that the new symbol corresponds to an empty state). This is to say that, in the resulting hierarchy of single symbols, sub-alphabets, and infinite universal alphabets, as a consequence of the nilpotent rewriting process, each recommencement of the universal alphabet corresponds to a complete repetition (at a higher level of semantic ontological physical structure) of the nilpotent universal computational semantic rewrite system. This repetition is therefore in common with the original infinite universal alphabet, realized by a QCE(N), where in the examples already given, of the RNA/DNA genetic code, and human natural language capabilities, the respective QCE(N)s are those of the prokaryote [22a] and Eukaryote living cells and of the human brain [22b-22l]. The further implication is that all living organisms, and indeed many of their subsystems, are QCE(N)s, including human organs, such as the human brain, and indeed the heart. For in relation to the human fluid circulation system, there can be little doubt that the heart is not just a mechanical amplitude pump for driving the blood, as simply an ordinary fluid, around the body's veins and arteries as fixed pipes, but that it is a 'phase' pump QCE(N) for the whole of the individual human organism, which moves the blood as now a 'living' fluid coherently around veins and arteries with their own living pumping actions, so as to optimize the entire fluid action of the body and brain in relation to whatsoever task the human organism is performing. The overall conclusion that can be reached from the nature of the QCE(N) model is, therefore, that all the livings systems above are individual quantum mechanically coherent systems, and that the nilpotent universal semantic rewrite system methodology has the capability to describe quantum computational units, such as QCE(N)s, that are both computer universal and computer constructor universal, so that the latter are able to make replicas of themselves, to produce new generations of the living organism in question.

The view presented in this paper of the QCE(N) as the single phase source of the universe's cosmological evolution, etc., also requires, in line with Feynman's sum of histories approach to quantum mechanics, that this phase action follows that of Huygens' principle of secondary sources, as formalized by Jessel [23h,23g]. For, as can be shown, the combined effect of such a source together with its secondary sources (also QCE(N)s) on a 3+1 space-time surface, can then be such that the source and its secondary sources cancel each other out, so as to satisfy the nilpotent criterion. An example of such a Huygens' cancellation is the phenomenon of anti-sound in relation to sound fields, by means of which a source can be nullified dynamically throughout an entire 3-dimensional space, by secondary sources of sound on its bounding surface. The evidence for such phase action in the case of the cosmos thus comes from observed galactic structure; for, as seen through the most powerful telescopes, the galaxies, as secondary sources of their cosmic source, will undoubtedly each correspond to a QCE(N) on the cosmic 3+1 space-time surface, such that the phase of quantum coherence of the cosmos connects them all together as in the Everett interpretation of

quantum mechanics, but in such a way that they are not hidden from one another as is usually envisaged for 'parallel universes'. Such a model based on Huygens' principle, thus says that all QCE(N)s are in fact part of the evolving cosmological 3+1 relativistic space-time wave front, plus subsequent wave fronts, with their secondary sources many times removed; and that as this quantum coherent phase precedes the original emergence of 3+1 space-time and matter, it could account for the so-called 'dark energy' effects [17a], observed through the acceleration term imposed on the cosmological redshift.

7 Conclusion

D&R's remarkable discovery, with its semantic approach to a computational language foundation of both physics and mathematics (thus explaining the undue effectiveness of mathematical language in physics), plus the evidence in support of the QCE(N), appear to furnish the highly likely missing links, including the experimentally well validated classical thermodynamic Carnot engine, to an improved testable modelling of physical systems, which is more than sufficient to warrant, we believe, their extended theoretical and experimental investigation. A particular example of such a testable missing link is the QCE(N) model of the Biosphere, that could advance a more correct understanding of global warming, and of the critical importance of biodiversity.

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