The Digital World Theory

(DWT)

Introduction

The DWT designates a common theoretical framework for modeling complex non-linear systems and their interactions or communications [M, SM], from elementary particles and their fundamental interactions to the modeling of living organisms and their environment.

It is “A New Kind of Science” [Wolfram]:

- A new methodology. A top-down design of the theory is used, starting from the analysis of the present state-of-the-art level in science, and with an ambitious goal as a target, since we cannot understand the parts in isolation, due to the interdependency of the fundamental questions.
- A new fundamental principle unifying energy and information is introduced, as an “upgrade” of Einstein’s equivalence principle between energy and matter, preparing us for breaching the ultimate frontier: the Mind-Matter Interface;
- A new physics content is provided: interactions, quantum or classical, are communications. The distinction between “system” (matter/apparatus) and “observer” (living organism / conscience) is a matter of nuances (info processing capability), not of principle.
- A new mathematics implementation of the physics interface: a discrete algebraic structure is introduced, the Quantum Dot Resolution with Internal/External Duality (QDR), prone for computer simulations, abandoning the classical continuum “ballast” (conceptual and computational).

It is a professional theoretical foundation, developed based on its specialized precursors: cellular automata, representations of categories, networks etc..

The Basic Principles of DWT

The key differentiating ideas are:

1) The Resolution Principle ("Zoom-in/out"): a hierarchic structure allows to model external details irrelevant at a given scale as internal parameters, as an effective theory. The principle is applied to the modeling of space-time-matter and cellular structures, networks alike.

2) The Duality Principle: implementing the resolution principle requires trading internal and external degrees of freedom (states). This is implemented as a pairing between the external configuration/state space and internal configuration/state space.

3) The Information Flow. The existence of a time flow is a too restrictive assumption. It is rather an “observational” parameter in any “System (evolving / computing)-Observer (eavesdropping) process”. Time is replaced by the pair: information flow (causality) playing the role of internal time corresponding to the evolution of the
observed system (quantum interaction or quantum computation/communication), and the external time, playing the role of a labeling of the observation as a received communication (message). In the resolution (modular) approach, any “elementary” process at a given resolution scale is a “black box” in Input/Output interaction with the environment.

4) Quantum Interaction is Quantum Computing. To build a common foundation for fundamental physics, biology and brain-mind sciences, quantum phenomena should be accounted for. The picture emerging in the DWT suggests that phenomena like subconscience, are emergent quantum phenomena. They are predominantly quantum information flow processes. Biological growth and learning processes are not suited to be modeled using “cellular automata”, yet by quantum cellular automata with dynamical programming capabilities enabled by the resolution and duality principles.

Targeted Areas

The present grant proposal targets the first two of the 21st Century Science Initiative’s program areas.

The Study of Complex (non-linear) Systems is targeted as a primary area: the QDR provides a “standard” theoretical tool for Application Developers within specific sciences (physics, biology, neurology, sociology etc.) and possessing a friendly interface (no need to know the implementation details!).

The second area targeted, Bridging Brain, Mind and Behavior, is directly affected by the DWT. The traditional boundaries Inanimate Matter-Living organisms, computer - brain/mind are shown to become irrelevant. They rather correspond to various instances of systems capable of information processing and interactions (exchanging bits/ qubits or states), modeled at various levels of detail (resolution). An essential common feature is an internal-external duality (hardware-software, brain-mind etc.), modeling the dynamical programming capabilities living and inanimate systems all exhibit in different degrees.

Due to the limit of the present document, analogies will be used to convey the main ideas and overall objectives. Technical details supporting the present claims are available at [VIRequest].

2. From QFT and Integrated Circuits to Living Organisms

Stepping back from the details involved in quantum physics, computer science and biology, a bigger picture emerges: there is no qualitative difference in the modeling and functioning of complex systems. They all exhibit an exchange of energy-matter and information, at various degrees, from a mere quantum interaction of elementary particles perceived as a somewhat strange “billiard game” (scattering) in a Wilson chamber, where classical motion seems to dominate apart from a flitting moment of the actual interaction (Feynman diagram), till the motionless process of thinking, which is dominated by the information flow. That the common features outweigh by far the apparent differences is
explained in the Project’s Specification Documentation to be released before May 21, 2006 [DWT v. 1.0].

Bellow we will try to convince the reader that complexity appears in disguise even at the level of fundamental physics, when modeling space-time and the fundamental interactions, not only in the process of designing integrated circuits or reverse engineering living organisms. The “revelation” comes from a brainstorming thought:

Quantum Virtual Reality is Reality Itself?

3. DWT: Conceptual Upgrading Imported Technology

The implementation of the new ideas used to design the mathematical-physics theory starting from the new principles stated, will be using the current mathematical methods (“imported technology”).

Non-linearity and the Perturbative Approach
Both quantum interactions between fundamental particles and quantum (or classical) communications between systems (emitter and receptor) are described by a common approach: the perturbative and multi-scale resolution approach. “Perturbative” refers to “adding” interactions to the free theory. “Multi-scale resolution” refers to the hierarchy of details within the model; the mapping system with the zoom-in and zoom-out capability is such a prototypical example.

At the fundamental physics level, for instance Quantum Field Theory, the complex non-linear systems are interacting elementary or composed particles. It is essentially a management of external and internal degrees of freedom (I/E DOFs).

At the biologic (social, economic etc.) level, the theory models interacting subsystems. It is a similar management system, where the observables (extensive or internal) refer to a different area of experimental data.

Relational-Hierarchic Data Bases and the Resolution Approach
The modeling process usually starts from delimiting the class of systems studied and by specifying the relevant details: what the parts are and what interactions are considered relevant. Our flexible approach, not requiring a fixed resolution, is reminiscent of the basic structure appropriate to implement a body of knowledge: the procedural knowledge data base management system (DBMS).

In both areas, a model is essentially a procedural knowledge data base. At a more simplified level, modern physics relies on categorical language (objects and relations, representations of a geometric category “decorated” with internal structure etc.), while the other areas mentioned rely on similar structures belonging the large class of Path Models (e.g. cellular automata, Markov processes, correlation models, neural networks etc.).

Two dynamics: Motion and Information flow
Motion is essentially a dynamics in external space while information flow is a dynamics in the internal space.
QFT “manages” both I/E DOFs as a theory of Feynman processes. These are a complexified and enriched version of Markov processes. Both motion and quantum information processing capabilities are present. Biological (eco) systems are often modeled as automata, networks etc., which fall within the same framework as above, exhibiting information processing as a predominant component over mechanical motion.

**Entropy and Riemann Surfaces**

One of the crucial discoveries explained in [DWT v.1.0] is the interpretation of entropy (or its opposite, information) as a flow corresponding to a current of moving charges, in the physical sense. In this way, a common framework is available for describing both motion of particles/waves and transfer of information/states. It is a unification of external and internal state spaces at the methodological level. At a more fundamental level, the requirement of duality (trading external and internal states) essentially represents and equivalence between matter-energy and information.

The impact of this unification may be only guessed at the present time. It affects the way we think and model “physical” phenomena, and removes the conceptual barrier separating them from “psychic” phenomena.

At the fundamental physics level we are finally able to provide a consistent high level interpretation of String Theory’s action. Riemann surfaces, which model the basic transitions between In and Out states (like in a Markov process), have the role of entangling the quantum information flowing through the process. The String Action is “just” a maximization of the capacity of the quantum process to communicate quantum information. The classical Minimum Action Principle has matured; we now understand that Nature maximizes the efficiency of Her communications!

Implied by the above explanation is that the DWT achieves a unification of the dynamics of external state space with the thermodynamics of the internal state space.

The fundamental new ideas, principles and suggested mathematical models, although developed from, and at the level of quantum physics, are far reaching scope; we believe that they will set new and long-term viable “standard” in science. Viewed as a “quantum cellular automaton”, the DWT approach guaranties its utility as a framework for modeling complex phenomena in physics, biology, neurology etc.

### 3. Methodology and the Research Questions

The top-down design of DWT traverses several layers of generality. Four main levels will be distinguished: **Philosophic Level, Physics Level, Mathematic Level, Computational Level**, together with the corresponding interfaces.

**Previous Work**

The *Philosophic Level* and its interface with the *Physics Level* are implemented in [DWT v1]. The document also contains a description of the available options and technical chapters needed to implement the *Mathematical-Physics Interface.*
The Research Questions

The list of the main objectives of the present GP, implying the corresponding research questions from [DWT v1], are:

1) The completion of the *Physics Level* together with

2) The documentation for the implementation of the *Mathematical-Physics Interface*;

3) The dissemination of the results in a form prone for being used by the impacted sciences;

4) The design of a *Computer Interface* for computations and simulation purposes.

A consulting period is scheduled during the author’s visit at the Institut des Hautes Etude Scientifique, fall 2006, where the present author was invited for the second time (see CV). During the first visit at IHES the author unified the work of Maxim Kontsevich on graph homology and deformation quantization with the work of Dirk Kreimer on Hopf algebra techniques for renormalization (QFT), opening the way for classification of QFT and generalizations [Publications]. Therefore, the technical tools needed for the completion of the *Mathematical Level* are well known to the author. Being discrete algebraic tools, they are appropriate for use in other areas (biology, brain-mind modeling, computer science etc.), provided that a simple user interface will be implemented.

The technical tools are also suited for a *Computer Interface*, in order to study the theory’s computational capabilities and predictions via simulations (recall: quantum virtual reality is the currently modeled reality).

Feasibility

The author’s competence in the role of PI (project manager) is demonstrated by the prior achievements (see CV), in addition of the previously mentioned supporting evidence. The determination comes from a life-long endeavor pursuing the same goal: understanding the fundamental interaction, unification with gravity, understanding space, time and matter. Probably due to the multi-disciplinary training including computer-science background, it become clear that one will not be able to achieve such a unification, without considering the “whole picture”, including entropy and information.

Open Project Strategy

The role of the DWT Grant Proposal is catalytic, rather then exhaustive. It provides a crystallizing center for a global contribution from the international science community. It is an Open Project and Web accessible. It mirrors the Open Programming strategy which produced LINUS operating system as an alternative for MS Windows.

The PI has the role of Project Manager, leading a small team of co-PIs and researchers designing the specification documentation of the theory: precise “blue-prints” for the mathematical interface. The present theories (String Theory, Loop Quantum Gravity, Neural networks etc.) provide the “programming tools” suited to implement the mathematical interface. The novelty consists in the conceptual edifice across disciplines
(Mathematics, Physics and Computer Science) and across generality levels (Philosophy, Fundamental Principles, Physical Theories, Mathematical theory).

5. Conclusions

The DWT is intended as a “trademark” of a new approach in modeling interacting and interactive systems, from fundamental interactions including quantum gravity, to complex systems like communication networks, i.e. models of natural and artificial reality alike! It gathers various “scattered” new trends consistent with the author's own research and philosophy, into a project description playing the role of a grant proposal for “A New Kind of Science”, and prone to “open science development”.

Its “motto” is “Quantum virtual reality (i.e. quantum computing) is reality itself (quantum interactions)” and the unification of energy-matter and quantum information is achieved by modeling information flow and energy-matter motion/flow together, as a hyper-dynamics unifying classical dynamics and thermodynamics concepts, by unifying external and internal state spaces via duality.

The scope of the framework provided by the DWT is broad. It is appropriate for any science which models the dynamics of complex systems consisting of interacting subsystems, with an internal hierarchy, and when the interaction has a dual role of communication which cannot be neglected.

Recall some major conceptual "upgrades" of DWT:

1) Complex systems are not well described by a foliation of the space of observed events into space (non-causal correlated) and time (causal correlated). The causal structure has rather a multi-dimensional relational and hierarchic structure, modeled in the DWT by the QDR with duality. Time plays the role of an external parameter; the internal dynamics controls the information flow;

2) The causal structure with “variable geometry” (I/E-duality) is a discrete model (q-digital!), not a continuum model;

3) A new Matter-Energy-Information Unifying Principle binding Einstein's energy-matter and Information is introduced, based on the well known balance between entropy and energy. It provides a common framework for a unified description of Mind and Matter;

4) It is a concerted modeling effort unifying contributions from Physics and Computer Science at the application level, under the auspices of Mathematics at the implementation level. It is mandated by the duality: Quantum Interaction is Quantum Computing, at the hardware level (interacting matter as a quantum computer) and software level (physics model - computer science interpretation). It also provides an “umbrella description” of interacting systems (System-System) and interactive systems: System-Observer (measurements), and Observer-Observer (communications).

This last unification, with implications both ideological and methodological, is probably the most valuable. It is the GUT feature of the DWT.
Bibliography

An extensive bibliography may be found at [DWTv1].


