Quantum Measurement: A New View

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{VIIA}

ABSTRACT

This report investigates the flawed foundations of standard quantum theory based on a misunderstanding of the role of measurement. The report is major part of a research programme (UET) based on a new theory of the electromagnetism (EM), centered exclusively on the interaction **between** electrons. All the previous papers to date in this series have presented a **realistic** view of the dynamics of two or more electrons as they interact only between themselves. This paper now posits a theory of how this microscopic activity is **perceived** by human beings in attempting to **extract** information about atomic systems. The standard theory of quantum mechanics (QM) is constructed on **only** how the micro-world **appears** to macro measurements - as such, it cannot offer any view of how the foundations of the world are acting when humans are **not** observing it (the vast majority of the time) - this has generated almost 100 years of confusion and contradiction at the very heart of physics. All human beings (and all our instruments) are vast collections of electrons, our information about atomic-scale can only be obtained destructively and statistically.

This theory now extends the **realistic** model of **digital electrons** by adding an explicit **measurement model** of **how** our macro instruments interfere with nature's micro-systems when such attempts result in human-scale information. The focus here is on the connection between the micro-world (when left to itself) and our mental models of this sphere of material reality, via the mechanism of atomic measurements. The mathematics of quantum mechanics reflects the eigenvalues of the combined target system **plus** equipment used for measurement **together**. Therefore, QM has constructed a theory that inseparably conflates the ontological and epistemological views of nature. This standard approach fails to examine **isolated** target systems alone. It is metaphysically deficient.

This investigation concludes that the Quantum State function (Ψ) is **not** a representation of physical reality, within a single atom, but a ***generator function*** for producing the average statistical results on many atoms of this type. In contrast, the present theory builds on the physical reality of **micro-states** of single atoms, where (in the case of hydrogen), a single electron executes a series of fixed segments (corresponding to the micro-states) across the atom between a finite number of discrete interactions between the electron and one of the positrons in the nucleus. The set of serial segments form closed **trajectories** with real temporal periods, contra to Heisenberg's 'papal' decree banning such reality because of his need to measure position and momentum at **all** times.

This is the first paper in the multi-paper series (UET7n), which is dedicated to analyzing, criticizing and replacing existing theories of quantum mechanics.

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1. INTRODUCTION

1.1 RESEARCH PROGRAMME

1.1.1 SUMMARY

This paper now reaches one of the primary goals of this research programme: a separation between the reality of nature (ontology) and the process by which humans gain knowledge of this external reality (epistemology); this paper presents a theory of how electrons behave when **unobserved** and what happens when humans attempt to **measure** them, as they interact at the atomic scale of reality. The electron has always been at the center of this research programme [1] and first appeared explicitly in the second paper [2] where its unexpected historical discovery was shown to threaten the dominant paradigm of Maxwell's theory of the electromagnetic (EM) **field** that is today presented classically, as if electricity exists in the form of a continuous fluid ("**charge density**"). The next paper [3] also included a summary of the first attempts to understand this new **discrete** form of electricity, which was referred to as *Classical Electron Theory*. A theory of large numbers of electrons interacting locally and remotely was also presented in this paper (*Mesoscopic Electrodynamics*) that reproduced the macroscopic results of Maxwell's mathematics without using any continuum concepts and only needing the physical hypothesis of **two-electron interactions**. Later papers in this programme continually exposed the attempts throughout the 20th Century to accommodate the discrete facts of the electron with the continuum concepts underpinning Maxwell's field theory (perhaps, attempting to salvage 300 years of intense intellectual investment in abstract mathematics). The fourth paper [4] focused on the **finite** temporal separations that are a primary feature of remote electron interactions. This enabled the theory to be extended to all distances and relative velocities. The result was a fundamental critique of Einstein's Special **Relativity** Theory (SRT), exposing it as a direct consequence of viewing "light", without including its sources. The new theory demonstrated the importance of synchronizing remote interactions (on the 'Light-Cone') at **two** different interaction **times**. This also showed that the (in)famous Lorentz transformations were a necessary constraint on the mathematics of instantaneous (local) field theories and did not require a massive revision in the commonsense views of the reality of space and time. The fifth paper [5] replaced the venerable view of the instantaneous Coulomb (electrostatic) interaction with a pair-wise, **ray**-like form of the dynamic EM **impulse**, whose actual magnitude diminished linearly with increases in temporal separation. Quantizing both the dynamical and kinematical activity between two electrons introduced **light-quanta** in a physical (rather than mathematical) manner. This also led to the natural emergence of positive electrons that become a complementary fundamental particle to the usual negatively charged electron. These two real entities became the **only** natural material objects needed in this fundamental theory of nature.

The previous paper [6] extended the quantization requirement to '**far**' interactions, which resulted in an invariant transverse impulse between 'static' pairs of electrons at macroscopic distances. This model was shown to be sufficient to explain **both** the wave characteristics of '**light**' and its discrete, low intensity interactions. It abolished the ideas of light as a **photon** or as a **wave** of 'force density'; i.e. an interaction is a relationship, not an entity (a real object with independent existence). A light-quantum is **not** an energy packet but the **quantum** of inter**action**, so it is not an entity with its own independent existence (i.e. **not** a "particle"). The next paper extends this approach to dynamical '**near**' interactions between electrons. A companion paper will extend this perspective to the 'pulsating possibilities' of electrons as they only interact **together**, while presenting a human observer with phenomena that are easiest to describe with the simple mathematics of waves; it is demonstrated that this does **NOT** mean that electrons exist as waves – they remain **particulate** in their fundamental ontological property, as **existing** at only **one** point in **space** at **every** moment of **time**: it is their interactions that oscillate over space and time – a fundamental change in philosophical (metaphysical) viewpoint. The next companion paper in this #7 series (UET7B) analyzes the basic assumptions used in both classical and quantum mechanics.

1.1.2 HISTORY

Historically, curious intellectuals have looked for patterns in nature. In the western tradition, this started to become formalized with the Ancient Greek philosophers. Over time, those who specialized in this aspect of investigating reality were referred to as "Natural Philosophers". Much of this activity was purely mental speculation, which resulted in endless argumentation. The rise of modern science began when many of the Natural Philosophers agreed that Nature itself must resolve these disagreements. This was the vital empirical step were actual manipulations of material reality, also better known as **experiments** (not just human observations), began to play an increasing role in resolving speculations. Until the end of the Nineteenth Century, the study of matter was dominated by astute experimenters, who used new technologies (such as the vacuum pump) or even invented new technologies (electric batteries), to discover new phenomena and new properties of matter in its various forms. This style of manipulating the world was contrasted with **abstract** investigations that had begun with Pythagoras and actively promoted by Plato as the only true form of knowledge: these investigations of timeless relationships were exemplified by pure mathematics. Since mathematics could be readily taught (and examined), this style of human activity soon dominated the education (and selection) of the social elites across western societies. It was not long before this academic approach began to encroach on the realistic model of what soon became known as science.

The great pioneer here was the polymath, Isaac Newton, who combined admirable, experimental skills with a rare, **imaginative** talent for mathematical innovation. His most dramatic contribution was his explanation of planetary motion using his conceptual model of inertial motion and his radical proposal for action-at-a-distance, attractive forces between masses (given the name ***gravity***) and a mathematical summarization as a continuous reciprocal **force**, whose strength varied inversely with their spatial separation. This was the foundation of classical mechanics and the subsequent introduction of **calculus** as the preferred mathematical description of nature: this defined the new orthodox model of science, where mathematicians calculated numbers to be compared with measurements.

1.1.3 PHILOSOPHY

Since many intellectuals in the western tradition have raised mathematics to its role as "the Queen of the Sciences", they see no need for any **conceptual** explanations beyond the symbology in their equations. In effect, they have **hijacked** physics, pushing empirical science into the background, doing no more than generating numbers that can validate their theories. In many cases today, it is deemed sufficient to conduct experiments in their own heads: so-called "thought experiments". This mind-before-matter approach is rejected here, where conceptual innovations are considered to be much more fruitful than inventing new equations. Recently, world-class specialists in mathematical physics, frustrated that their latest theories (e.g. "Strings") cannot expect to be examined experimentally have suggested that rationalism alone can be relied on to advance knowledge of nature. This would remove science from the grounded world of physics before 1900, where new experiments dictated the new directions of physics while mathematics was viewed only as a tool to produce numbers, not explanations. In her immensely readable book [8], historian Jones retells the quantum tale very well, showing how a handful of men '*fired by ambition, philosophical conflicts and personal agendas*' created the quantum revolution. She clearly shows that there was never a consensus, so that by the Fifth Solvay Conference '*there was such ill will that most were barely on speaking terms*' as they presented their three competing versions. The quantum revolution failed to produce a single philosophical worldview, which many leading academics demanded. The immediate result of this impasse was for physicists to abandon the need for a philosophical theory of quantum physics. Indeed, by 1950, philosophers of science were expelled from their long-time home (the Natural Philosophy Temple). Ironically, the three competing versions were soon shown to be mathematically equivalent but the **interpretation** puzzle was still left unresolved. A related paper [7] summarizes the QM (and CM) problems.

1.1.4 MOTIVATION

A major motivation of attempting to create a new quantum theory is to refute the widely held (and self-congratulatory) **opinion** that physicists have already created a perfect theory of the micro-world. A companion paper has provided a detailed critique of standard QM, including its failure to provide an analytical model of multi-electron atoms (even the simple helium atom with only two electrons) because the infamous **Three-Body** problem has defeated all mathematical attempts to describe the dynamics of three or more objects which are continuously interacting between every pair of them. In effect, Bohr's model only provided an 'explanation' of the Periodic Table of Elements by ignoring **all** EM interactions between every circulating electron. Contrary to the common perception, Bohr did not make much progress with this problem [9] but it cleared the way for Pauli to make his major contribution with his "exclusion principle" [§1.2.5] so that QM could evaluate good approximations later. The explanation of the Periodic Table in this programme is deferred until our future paper on Multi-Electron Atoms.

1.2 OBJECTIVES

One of the principal objectives of this research programme is to refute the modern view that the goal of theoretical physics is to produce a set of **equations** that can be used to make predictions that numerically agree with the numbers obtained from the corresponding experiments. While this is a worthy goal (qua *Ptolemy*), it is not seen here as sufficient. Educated people in the last 300 years have expected physics to provide a comprehensible model of the material world, which it did with *Classical Physics* until 1925. After that year, physics continued to produce mathematical theories but these became increasingly difficult to **interpret**. Too many professional physicists readily accepted this difficulty with the defeatist view that the atomic world is too remote from normal experience, so that it operates in mysterious ways that can only be represented by mathematics. This approach was so deficient that even when conceptual contradictions arose between alternate mathematical schemas (such as waves and particles), these problems were swept away with the rhetorical flourish of simply naming them "**paradoxes**". This programme refuses to go along with this professional consensus and has attempted to create a single **ontological** model of the **electron** that can not only explain its apparent "weird" behavior but is readily visualizable by most non-mathematicians. This programme is committed to the view that physics is 'Natural Philosophy' and must explicitly include metaphysics [3] by first creating new stories before falling back on mathematics. A new revisionist view of the history of QM has developed since 1945, whereby all the quantum issues were considered to have been resolved in the Fifth Solvay Conference of 1927, when Heisenberg and the 'Copenhagen School' defeated Einstein and the 'Old Guard'. The opposite view has been documented recently in a new book by science historian Sheilla Jones [8]. She concludes that: '*the subsequent confusion and uncertainty that has bedeviled quantum physics undermine the idea that it was all figured out a long time ago*'. In her introduction, she dares to write that: '*If after such a long time all the smart men and women who work in physics have not been able to reconcile the two sets of rules for the universe {classical and quantum}, it's natural to wonder if one – or both – of the sets might just be wrong. …*

1.2.1 REALISTIC MODEL OF QUANTUM MECHANICS

It was only around 1900, that physicists finally had the chance to understand the real atomic basis of nature. It was only then the new discovery of the electron provided us with the true foundation of electricity. Before that event, there had been bitter controversies on the nature of Nature; many scientists (such as Ernst Mach) still disputed the reality of atoms. Unfortunately, science wishes to cling to its theories even when major discoveries cast grave doubt on their foundations. This was the case with light, where Maxwell's Aether-based theory of electromagnetism (EM) had become almost universally accepted by physicists with Hertz's revolutionary experiments on remote-induced induction that was interpreted as a proof of Maxwell's EM wave theory.

This research programme is dedicated to the proposition that Newton's metaphysical scheme (including his laws of motion) is a universal foundation for all of physics, at **all** scales of nature, while Maxwell's theory of electromagnetism is strictly limited to interactions of macroscopic collections of electrons. It is shown here that QM has been the rearguard defense of field theory that, (it is believed here) has been the stumbling block of understanding atomic systems. As science historian Jones concludes [8]: '*There have been no new fundamental laws of nature discovered since the 1970s and there is no math-driven theory that can reconcile the classical and quantum worlds.*' In this programme's view, this is the inevitable result of the mathematics-only approach initiated by the quantum theorists in 1925. The obvious dead-end should have alerted physicists that they had taken the wrong turn and been driving down the wrong road for a long time. **Understanding** is driven by coherent stories, not consistent abstract symbology (i.e. mathematics): physics is studying reality – not mental models of human-created definitions.

1.2.2 MICRO/MACRO THEORY OF MEASUREMENT

This research programme takes the view that QM was the result of an illegitimate alliance between the ancient Platonic view of reality **as mathematics** and the obsession with anti-metaphysical (especially anti-religious) philosophies of certain modern thinkers, such as exemplified by the **Positivists** around 1900. Indeed, QM is analyzed here as only a theory of measurement and not as a theory of material reality (i.e. physics). Indeed, this paper was motivated (in part) by the belief that the quantum wave function is only an eigenfunction of measured situations and only represents the microscopic/macroscopic reality of interactions between electrons in an idealized, statistical manner, so that the continuum mathematics (used in physics since 1700) can still be retained. Just as the Earth (since Copernicus) is no longer viewed as the center of the universe, it can no longer be maintained that humans are at the center of **existence** – a position implied by several interpretations of QM, including the orthodox '**Copenhagen Interpretation**'. It is expanded below why the foundational scheme of QM is fundamentally **flawed** – there are **no** 'ideal' experiments that can be so isolated that **all** the same initial conditions can be set (by humans) to be **exactly** the same, which is a key (unstated) assumption underlying all QM.

1.3 OVERVIEW

Here, the contents of this paper are summarized with a brief description of each section and why the particular material was included.

1.3.1 APPROACH

This research programme is founded on the dual pillars of history and philosophy, believing that both are required to make fundamental progress in understanding nature. Contrary to the modern view, knowledge of the history of science is needed to understand how contemporary science has reached its present situation, especially when it finds itself in an impasse. It is also believed here that metaphysics is a necessary component of any theory of reality [2]. What is rejected throughout this research programme is the present opinion that mathematical equations form a sufficient explanation of the world. Worse, the mathematical view has now come to dominate theoretical physics and it is assumed that this approach is creating an asymptotic view of the truth.

1.3.2 A NEW METAPHYSICAL SCHEMA

1.3.2.1 RESTORATION OF NATURAL LANGUAGE

The idea of simply doing theoretical physics as an exercise in applied mathematics has been a demonstrated failure with **NO** new concepts arising or even reaching the level of a useful technology, as happened to much of earlier physics that provided visualizable models for both professional physicists, engineers and common folk. Bohr and Heisenberg, the originators of the so-called '*Copenhagen Interpretation*', believed that they could retain natural languages while forcing everyone to accept contradictory concepts (particles and waves) as a new 'mysterious' property of the micro-world by simply invoking a new 'scientific' principle, which Bohr called '**Complementarity**'. Heisenberg expected the rest of the humanity to give up the "*illusion of the world*" that we experience on a daily basis when we come to think of atomic systems but still insists that the rest of the descriptions of such experiments can continue with the rest of our standard vocabulary and concepts. The present theory actually succeeds in providing a non-contradictory, unitary explanation of all these atomic scale experiments using natural language and a **visualizable** model of particle physics that extends Newton's original views with a few, reasonable hypotheses of 'near' electron interactions, at this tiny scale of reality.

1.3.2.2 METAPHYSICS

Central to this programme's efforts to create a sensible alternative to QM is the view that physics has made a major error in retreating from its close historical association with philosophy: especially the Philosophy of Nature. If physics is to be grounded in material reality, then it is **not** sufficient that it simply conduct experiments on nature; it is important that theoretical physics **represent reality** as accurately as possible; otherwise, it simply degenerates into a branch of applied mathematics. This means theoretical physics must explicitly address the core issues of **metaphysics**. The common practice today is to dismiss all metaphysics from physics – this dismissal is actually an implied metaphysical position that is intellectually lazy, as it is rarely justified. The position taken here is that many of the problems of QM tie directly back to the two principal areas of metaphysics: ontology (existence) and epistemology (knowledge). The study of ancient natural philosophy demonstrates that intellectuals have long tried to eliminate **time** from the heart of reality; this was quite acceptable to the Platonists, who venerated timeless geometry as the perfect intellectual creation. We recover the centrality of time with the researches and theories of Galileo and Newton. Newton needed the concept of continuously evolving universal time; this brought in to mathematical physics the most powerful parameter in classical physics. This step required Kant (an ex-Newtonian) to formalize the core ideas of space and time as universal intuitions in our human language models of reality. The key idea in ontology is the concept of an **entity**: here we limit this to real 'things' or individual examples of material objects with implied properties of stability over time and their own independent existence within a finite region of space. Historically, physics began with theories (hypothesized entities): Newton had his "matter corpuscles", Maxwell also needed this atomic idea to view gases as discrete molecules but he needed a "luminiferous aether" for his model of light, which Planck could only model mathematically as a vast sea of harmonic oscillators.

1.3.2.3 PROPERTIES OF ELECTRONS

This programme is firmly positioned in the ancient tradition of the **atomic model of material reality**. This view originated with Leucippus and his pupil, Democritus. Although these thinkers perceived the world in terms of localized particles, they had no idea of how this idea might manifest in the real world. It was not until the discovery of the **electron**, at the end of the nineteenth century, was realizing this dream made possible. In contrast to most of the standard efforts in so-called "particle physics", the present theory only requires one particle, the **electron** to define all the other fermions. This new theory does not keep inventing new particles to explain the embarrassing plethora of the Standard Theory but posits new properties of the electron; in fact, it requires new modes of interaction between electrons but it does not view these styles of interactions as new particles ("bosons") but as the microscopic manifestation of the universal electromagnetic interaction.

1.3.2.4 TRIPARTITE SCHEME

Science cannot ignore reality; two facts must be acknowledged: the macroscopic scale is vastly larger than the invisible atomic realm and humans have constructed a symbolic language to describe this larger world using our incredibly powerful visual imagination. Now, although mathematics is a powerful symbolic scheme it needs to draw on our **imagination** for it to be extended and to associate it with aspects of reality beyond our direct senses. This section of this paper explicitly includes a three-part conceptual solution that brings together all major components of nature: the basis is the idea of universal **reality** – the existence of entities of various physical sizes with the smallest examples being the electrons. The total collection of these objects interacting between themselves in a pairwise, **discrete** interaction (by-passing the **3-Body Problem**) constitutes reality. This perspective provides a structural model of macroscopic-scaled objects, like humans and their experimental equipment. It also encompasses the range of atomic phenomena where a few (sometimes only one) electron inter**acts** with our special equipment. Unfortunately, no real atomic system can be isolated from the rest of reality, which leads to a level of complexity that exceeds human understanding; so we artificially introduce an **idealization** of such atomic systems but only in our imagination. Our simple mathematics is sufficient to perform calculations in this ideal space and communicate the results across multiple human imaginations. This approach separates out the **Measurement** arena (or laboratory) where all the vast complexity of reality, including the non-determinable interactions with the target systems occur; these many (unobserved) variations account for the statistical results found whenever scientists try to observe the atomic world. Tragically, all prior versions of quantum theory did **not** separate out the effects of measurements using the mistaken belief that scientists could reproduce experiments **exactly**. Mathematical physicists then created a theory that 'blended' the internal dynamics of the target (atomic) system **AND** their macroscopic equipment to generate numbers that reflected the statistics found in experiments – interpreting the results as due exclusively to the statistical nature of the target atomic systems themselves – thereby persuading themselves that all of nature was inherently statistical and non-deterministic.

1.3.3 NEW MODEL OF MEASUREMENT

The philosophy of **Positivism** swept the world of science around 1900; it strongly influenced most of the scientists who created quantum theory. In summary, it would be unscientific today to deny the reality of the atomic world but it would be equally foolish to focus only on atomic scale phenomena and ignore the human scale; both scales of reality are given **equal** weight in the present theory. Intellectual progress becomes possible again, when the full power of the human visual imagination (developed in the macro world) can be brought to bear in developing models of the microcosm; beating reliance on linear rules of symbol manipulation (mathematics).

1.3.3.1 OBSERVABLE S

This section begins with a brief summary of the centrality of measurement in the mathematical theory of quantum mechanics. Only certain functions are identified as Hermitian linear operators and assumed to represent "**observable**" properties of the target system. The critical assumption in all formulations of QM is that the integrated average of these functions represent the long-term average of very many exactly **repeated** measurements of this property in the laboratory. Another important step which is quickly introduced, before moving on, is the use of the **Hamiltonian** formulation of classical mechanics. This is centered on the classical model of an isolated particle's energy, viewed as the sum of its energy of motion (kinetic energy) and its 'energy' of position (**potential energy**). The latter is an invented technique to replace the many interactions of the target particle with a differentiable function of location only, which replaces the dynamic activity with a static, timeless function of spatial separation. This initial classical **particle** view is then mathematically transformed into a **wavelike** view using the de Broglie/Schrödinger transformation of momentum to wavelength (actually to another partial derivative operator with respect to the spatial variable). Once the physical model has been magically transformed into a differential equation, then the vast machinery of the **calculus** can be brought to bear to 'solve' these equations.

1.3.3.2 QM MEASUREMENT ASSUMPTIONS

This short section is introduced to expose the critical temporal assumptions underlying the human act of measurement of properties of atomic systems. These assumptions are analyzed from the perspectives of simultaneity, repeatability and directness. Another classical concept 'smuggled' into the heart of quantum mechanics is the concept of '*instantaneous*' **momentum**; originally introduced by Isaac Newton, with his temporal differentiable functions as the foundation of the theory of motion, this was another idea that should have disappeared when the Positivists insisted that only 'measurable' concepts should be retained in Natural Philosophy (see UET7B).

1.3.3.3 QUANTUM STATES

One of the vaguest ideas in QM is the notion of the 'state' of a quantum system. This was an attempt to import the idea from CM that a mechanical system could be characterized primarily by the locations and momenta, at every instant of time, of every one of its constituent particles. This became extremely difficult after Heisenberg had abolished the particle concept from QM; Schrödinger still had his 'wave function' (psi wave), so this took on the role of state function (all knowledge was built into only the psi function). Just because Heisenberg could personally make no progress by retaining the particle concept, is not viewed in the present programme as a sufficient reason for abolishing this fundamental entity from the study of mechanics at the quantum scale of reality. Indeed, in later subsequent papers it will be shown that this foundational concept still has a central role to play at all levels of mechanics. Here, this idea is restored in the form of electron trajectories (or orbitals) when the atomic electron periodically interacts with the atomic nucleus on a non-measurable, micro time frame. It is at this theoretical (idealized) level that the idea of classical system state is resurrected. By proposing that these microstates form the deeper (hidden) reality of the psi function that the meaning of QM measurement is known.

1.3.3.4 KNOWLEDGE AND MEASUREMENTS

This section is introduced as a deliberate act of 'educational theatre' to make clear the distinction between reality and our awareness of reality, especially when viewed from a probabilistic perspective. It is cast here as a little drama between a fully aware experimenter (who could also represent our fully functional sensory apparatus) and a 'blind' intellectual, who must learn about the real world. This little play is also given a mathematical description to illustrate the probability mathematics of QM to readers unfamiliar with these ideas. This 'entre-act' leads naturally back into a discussion of **existence** – a richer way to view objective reality, particularly when it is combined with the assumption of the *Persistence of Existence*. One cannot deny existence and still believe in reality.

1.3.3.5 ALGEBRAIC MEASUREMENT MODEL

The focal chapter (III) wraps up with a mathematical representation of all these measurement ideas using the metaphysical schema that was presented in chapter II, where the Idealization space is explicitly invoked to represent the ideal of an atomic system, which can be isolated from the rest of the universe while it evolves alone with only its internal interactions defining its evolution over time. The key here is the explicit use of the idea of long-term averages, which bridges between mathematics and reality, with all the messy (and incalculable) effects of numerous and random interactions between the target atomic system and external reality, moved into the final acts of measurement. This chapter concludes with a critique of the orthodox statistical and uncertainty interpretations of quantum mechanics.

1.3.4 SUMMARY AND CONCLUSIONS

The paper ends with a 'Summary and Conclusions' that focuses on the implications of the material covered and the new results herein obtained, along with brief **previews** of future papers in this series.

2. A NEW METAPHYSICAL SCHEME

The main objective of this research programme was stated in the first paper [1] in this series, namely: "*to restore the role of metaphysics and visualization in the evolution of the fundamentals of physics*". Indeed, the view is taken that without any philosophy, theoretical physics becomes indistinguishable from applied mathematics. In fact, this programme adopts the aggressive position that '**theoretical physics is metaphysics**'. The innovations here have their roots firmly in the valuable traditions of natural philosophy.

The challenge of using of mathematics alone to describe reality was first raised in the fourth paper [4], where the key role of human **imagination** was proposed as the link between reality and our awareness of that reality. This whole research programme is grounded on the primacy of **material reality**. Some may propose other parts to the idea of reality but physics is sufficiently challenged in its project to just understand the material elements of the world so that these possible extensions will be bypassed, at the moment, except for the key role played by the human imagination. This was not the arrangement that René DesCartes made with the Catholic Church, where Natural Philosophers would only study material reality while theologians would focus on the mind and spirit; most of western philosophy has suffered from this dualism ever since. It is time to reintegrate the study of reality.

2.1 THE TRIPARTITE MODEL

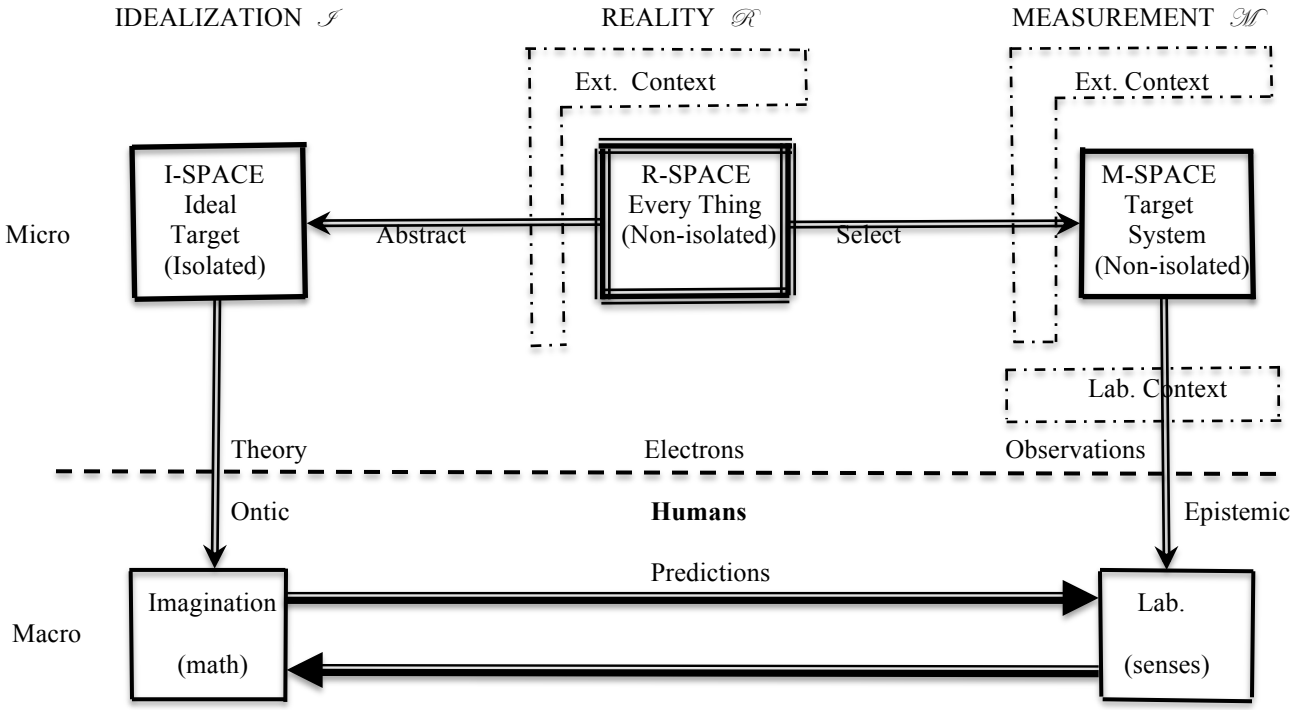
The following tripartite scheme was sketched earlier; this is now elaborated here in much greater detail. The first of these three realms (or levels) is that of **reality** itself ($\mathscr{R}$). This is logically centered on the existence of all humans but underlying this macroscopic level is the microscopic level that is grounded here in the plurality of electrons. These are taken to be the only existents needed to construct the material world (as the remainder of this research programme will demonstrate).
Even each electron is defined here only recursively in terms of its *interactions* with all the other electrons in the universe. In the present theory, these interactions are considered finite even at very large distances but the chance of an interaction between two very remote electrons is close to zero. Nonetheless, **no** finite collection of electrons forming a system (such as an atom) can ever be considered to be completely isolated from all the electrons outside the system electrons. So, when humans are analyzing the actions of a target system then these external interactions must also be seen as having a role to play. The electrons that are outside the target system will be referred to as the "external context". Unfortunately, even a single target system and its external context is far too complicated for humans to understand, so we create two others realms: the idealized, **isolated** view $\mathscr{I}$(called here "*I-space*") and the **laboratory** or measurement view $\mathscr{M}$(called herein "*M-space*").

I-space only consists of the target system without any external interactions; that is, absent its external context. This idealized view is constructed in our imaginations and can be communicated to one another using the tools of language, images and certain mathematics, such as Euclidean geometry and algebra. This view explicitly excludes calculus that is seen as a tool relying on the Continuum Hypothesis, which has been excluded from this approach from the very beginning. **Calculus** is one of those areas of mathematics that has smuggled in the concept of **infinity**, which is also forbidden here, being seen only as a theological concept introduced to minimize the psychological pain of the knowledge of the finitude of our individual existence. The concept of the infinite has clouded human thinking for years and it cannot be observed in M-space. The benefit of the I-space approach is that it does not pretend to be describing reality directly, so it can introduce purely imaginary concepts that do not need to exist in the real world, such as co-ordinate reference frames and point-like observers 'located' at the origin of such constructs. In such a space, model parameters can be used, such as co-ordinate numbers that can also be introduced in terms of multiples of units of space and time that are way too small to be reproduced physically but may be calculated to agree with scales that are achievable by scientific technologies. An evolutionary parameter (like $\underline{t}$) can play the role of time without having to possess all the characteristics of the real temporal concept (denoted as t).

M-space is familiar to **experimental** physicists. It reflects the major step in human understanding reality when humans first systematically adopted the empirical analysis of nature using our common sensory apparatus to resolve intellectual disputes, arising from purely speculative imaginings. This was enhanced when it was agreed that repeatable experiments were the epitome of this approach. Nature rewards our activities in this area by exposing her secrets to systematic investigations. This approach also minimizes fraud and process errors. Unfortunately, physicists have obsessed on seeking numbers from this activity while minimizing qualitative surprises. The benefit of seeking numbers (i.e. conducting measurements) is that such numbers can sometimes be compared with the results of theoretical investigations in I-space. However, it is critical that we always remember the superfluity of theory: there can be more than one theory capable of describing any area of reality, so that numerical agreement is no more than a necessary condition for a good theory but it is not sufficient. One of the best examples of this superfluity is the agreement between Sommerfeld's elliptical orbit model of the hydrogen atom and Dirac's QM model that includes relativistic spin. This agreement has been called: "*the most remarkable numerical coincidence in the history of physics*." [9] This incredible agreement was still not considered sufficient to give Sommerfeld's model the same credibility as Dirac's, which exhibited new and advanced, sophisticated mathematics.

It is a pity that no consensus has yet developed as to what constitutes a superior theory in physics. However, conceptual clarity must be rated highly, while the ability to visualize can often help extend a theory in new ways as it invokes the most powerful feature of the human mind - visual imagination. Usually, reaching this level enables many people to agree that they "understand" the phenomenon under consideration.

The following diagram illustrates the tri-partite metaphysical scheme for analyzing parts of material nature.



This diagram also illustrates the power of visualization to communicate information between human minds, especially about objects and relationships. There is limited use of language (only verbal 'tags'), no mathematics while the figures could be any shape or color.

The centrality of open-ended reality demonstrates that it is the ground of all human activity and knowledge but it must be **processed**, to be grasped by a finite human being. The intellectual act of **abstraction** is required to isolate a piece of reality (this moves the focus into I-Space). Alternatively, the act of selecting a subset of stable electrons (e.g. an atomic system) will isolate a piece of material reality to make it a suitable subject of examination by experimentalists in a laboratory.

The left-hand set can be isolated to provide a basis for pure mathematics. The right-hand set is the basis for the common experience of all human beings, who need to interact with reality but are not interested in generating numerical objective measurements.

The M-Space explicitly adds the context introduced by the experimentalist and is designed to show that what they measure is not an example of nature "left to itself" (Kant's *noumena* or *'ding an sich'*). Unfortunately, this 'corrupted' piece of reality is what the theory of quantum mechanics is designed to address, along with all its **unknown** contextual and laboratory inter-actions. The present theory (UET) covers all four outer nodes in this diagram; it only excludes complete reality in the middle, which is far too complex to be analyzed directly. It is hoped that this schema will help clarify philosophical discussions about how humans describe and discuss the micro-world of electrons. It will be used in the remaining expositions of this research programme, whenever measurements need to be analyzed.

3. A NEW MODEL OF QUANTUM MEASUREMENT

3.1 THE STANDARD QUANTUM MEASUREMENT MODEL

3.1.1 OBSERVABLES

The idea of macroscopic measurement of the target (atomic) system is intrinsic to the mathematics used in QM. The key assumption is that such a repeatable measurement [10] of a target property (called an "**observable**") can be represented mathematically by a linear, differential operator **A** corresponding to the **property** A that has a possible set of real number values $\{a_n\}$ that are the eigenvalues of **A**, each associated with a complex eigenfunction $\psi_n[x]$, through the equations: $\mathbf{A}\ \psi_n[x] = a_n\ \psi_n[x]$. Since the numbers a_n are real then the operators **A** must be Hermitian (or self-adjoint). This means that for any two regular functions Ψ and Φ then the Hermitian operators **A** satisfy:

$$\int dx\ \Psi[x]\ (\mathbf{A}\ \Phi[x])^* = \int dx\ \Phi[x]^*\ (\mathbf{A}\ \Psi[x])$$

Where the integrals are taken over **all** possible parameter $\{x\}$ values, usually assumed to be ± infinity.

This means that the **long-term** average value, when in state F, of the results of **repeated** measurements of an observable, A is:

$$< A >_F\ =\ \int dx\ F[x]^*\ \mathbf{A}\ F[x]\ =\ \sum_n (W_n)^*\ W_n\ a_n$$

John Stewart Bell spent much of his life thinking about measurement issues in QM [11]. He concluded that Bohr provided the correct insight into this issue when he stated that: "*the result of a quantum 'measurement' does not usually reveal some pre-existing property of the (target) 'system' but is a **product** of both 'system' and 'apparatus'*." The problem with this view is that the apparatus is a macro object with poorly defined (ambiguous) boundaries. This was Bell's motivation in introducing his innovative idea about "**beables**", restoring the primacy of ordinary language and objective properties to real objects. The present paper attempts to resolve this central but confusing issue. When our equipment is designed to measure the particulate properties of an atomic object, such as an electron, then it is no surprise that our results appear in terms of such properties, like energy and momentum. However, when the experimenters use equipment designed the measure the oscillatory properties of atomic objects, then results are presented in terms of mathematics associated with wavelike phenomena. The **mistaken** interpretation then becomes that an electron **exists** as both a particle and a wave.

3.1.2 CRITIQUE OF QUANTUM MEASUREMENT MODEL

There is one final quantum rule that must be introduced when mapping real systems, namely that the energy of a one electron system, with momentum P in a potential U, is represented [12] by the **classical** Hamiltonian function H, where: $H = P^2 / 2m + U[x]$. The **key assumption** is that there is such a classical system description defined by a timeless function of potential energy U[x]. This is then transformed by substituting the operator forms for the classical linear variables, x and P. It is not a casual coincidence that the **only** two sets of **complete**, orthogonal functions that are used are plane waves and spherical harmonics; nor that the **only real world system** that has been solved with all this sophisticated mathematical machinery is the simple (spherically symmetric) hydrogen atom; the analogue of the only real world solvable classical system: the 2-body (planar) Keplerian planetary system.

Even though there are physical systems whose states cannot be represented by such continuous functions, there is always a precise analogue of the central idea of linear superposition and this is the principal value of Hilbert Vector spaces - the method introduced by Dirac in his radical formulation, where states are represented mathematically by **infinite** vectors in this Hilbert space. Even this advanced mathematics still assumes that an identical experiment can be repeated a large number of times, with the system being assumed to be exactly **in the same state** before each measurement. This then allows long-term averages of measured values to be interpreted as relative frequencies. Despite the central idea of superposition, any one measurement only discovers one single value; this is referred to as the 'measurement problem' or the 'collapse of the wave function' but this mechanism is not made explicit anywhere in the mathematics of QM. Any future evolution of the system **then** occurs according to the time-dependent Schrödinger equation, assuming the system **was** in the state corresponding to the measured value.

3.1.2.1 QM MEASUREMENT ASSUMPTIONS

The **act** of measurement is central to all modern versions of Quantum Mechanics (QM). The mathematical model of measurement has made three major assumptions that have led QM into a dead-end. These assumptions may be called: a) Simultaneity b) Repeatability c) Directness. Each of these will be discussed next.

Simultaneity

It has usually been assumed that when two variables are to be measured (say A and B) then it is always possible that both measurements can be performed simultaneously. This is the QM equivalent to the classical assumption that velocity can be measured instantaneously. The reality is that all measurements take a finite time δt so that if a local observation of type A is measured at time t then this will be represented symbolically as **A**[t] so that an "immediate" measurement of type **B** can then occur at time t' = t + δt and will be represented by **B**[t']. When this pairwise operation is represented by time-based vector states |S[t]> then this new alternative view becomes:

$$\mathbf{A}\,|S[t]> \;=\; a\,|S[t+\delta t]> \;\Leftrightarrow\; \mathbf{B}[t+\delta t]\,\mathbf{A}[t]\,|\,S> \quad \text{not} \quad \mathbf{B}[t]\,\mathbf{A}[t]\,|\,S>$$

In effect, mathematicians have too readily assumed that their limit process $\delta t \rightarrow 0$ can be achieved by physicists in the laboratory; a **failure** that once again demonstrates that their professed positivism or operationalism is actually fraudulent.

Repeatability

In order to achieve a statistical average, it must be assumed that repeating an experiment can begin with **exactly** the same conditions. It has never been proven that two situations are ever 100% identical in reality [13]. We shall show later that this is **never** the case. This is the reason why a spread of possible eigenvalues is observed after attempts at repetition. It is this misunderstanding that has led to the bogus idea of '**Superposition**' [14]. One quantum state never has all these possibilities 'latent' within it (as often assumed) but macro attempts to replicate this 'single' state set up a similar one with small variations in the desired properties.

Directness

It is always assumed that the observation of a physical variable is measuring a real property of the target system. In reality, these operators (whether represented mathematically by matrices or differential operators [15]) are designed to return **statistical** values, **not** unique physical or micro-values of actual systems. Thus, the eigenstates of these QM operators are purely mathematical constructs with laboratory time t, not representations of micro-reality involving formal (but unobservable) micro-time variables $\underline{t}$. Thus, if real variables, each with a value q', actually exist for an observation of type Q then statistical results form a set {q'}. So, it is possible to define two sets of "states" or **sets** of eigenfunctions: QM: $|\,S[t]>$ and CM: $|\,S[\underline{t}]>>$, where:

$$\mathbf{Q}\,|\,S[t]> \;=\; Q'\,|\,S[t+\delta t]> \quad \text{and} \quad Q\,|\,S[\underline{t}]>> \;=\; q'\,|\,S[\underline{t}+\tau]>>$$

The basic hypothesis here is that there is a linear relationship between repeated measurements at laboratory times t_j and real values corresponding to micro-reality sampling at times $\underline{t}_\mu$, from a set of different electrons, each distinguished by an existential label α.

$$Q[t_j] \;\Rightarrow\; q'\,[\alpha\,;\,\underline{t}_\mu]$$

3.1.2.2 MEASUREMENTS and ATOMIC ORBITALS

Dirac developed his approach to QM by an explicit appeal [16] to "**classical analogy**", which he then applied to a dynamical system composed of a number of interacting particles. Rather than working with the Cartesian co-ordinates of all the particles, he preferred to work with 'canonical co-ordinates' and their associated momenta {q_r and p_r}, as it was "*more convenient*". This was his way of introducing classical **Poisson Brackets** of pairs of variables {[U, V]}. As Dirac knew [17], the simplest Poisson Brackets involve the canonical co-ordinates and their momenta themselves; since:

$$\{[q_r, q_s]\} \;=\; 0 \;\;;\;\; \{[p_r, p_s]\} \;=\; 0 \;\;;\;\; \{[q_r, p_s]\} \;=\; \delta_{rs} \;\equiv\; \{\text{Kronecker delta function: 1 if } r = s \text{ or } 0 \text{ if } r \neq s\}.$$

Dirac then simply assumed his quantum commutators, $[\mathbf{Q}_r, \mathbf{P}_s]$ mapped directly to the Poisson Brackets, so his **Quantum Rules** then obeyed the formal classical rules:

$$[\mathbf{Q}_r, \mathbf{Q}_s] \;\equiv\; \mathbf{Q}_r\,\mathbf{Q}_s - \mathbf{Q}_s\,\mathbf{Q}_r \;=\; 0 \;\;;\;\; [\mathbf{P}_r, \mathbf{P}_s] \;=\; 0 \;\;;\;\; [\mathbf{Q}_r, \mathbf{P}_s] \;=\; i\,(h/2\pi)\,\delta_{rs}$$

The present UET connects to Dirac's quantum approach by invoking physical principles, not purely mathematical arguments. The key here is to challenge the link between the quantum theory of measurement and its usual mathematical basis, when statistical averages of pairs of variables are involved: i.e. measured averages map to QM calculations: $<\mathbf{B}\,\mathbf{A}> \;\equiv\; <\Psi\,|\;\mathbf{B}\,\mathbf{A}\;|\,\Psi>$

As above, we challenge the implicit temporal assumptions involving Simultaneity, Repeatability and Probability. It is always assumed that measuring two variables (e.g. A and B) can always be done at the same time i.e. **B**[t] **A**[t]. In the present theory, an electron's interaction with other electrons are assumed to be "**saturated**", so that only **one** external electron (in the measuring device) may interact with only one of the atomic electrons in one of the atoms in the target system at a time; so there must be a **finite** time difference δt (at least one chronon, τ) between two consecutive measurements. Each explicit variable (e.g. **A**) corresponds to one act of measurement, i.e. one interaction between a target electron and the measuring instrument.

$$\mathbf{B}[t]\,\mathbf{A}[t] \;\Rightarrow\; \mathbf{B}[t+\delta t]\,\mathbf{A}[t] \qquad \text{Equation – I.}$$

The computed results are assumed equal to the mathematical average of multiple experiments, where each experiment is assumed identical with all the other experiments. In the present theory, the atomic systems involve orbital systems that are periodic over N interactions, at micro-times $\{\underline{t}_1, \underline{t}_2, \underline{t}_3, \ldots, \underline{t}_N\}$, while each experimental measurement, involving laboratory times $\{t_j\}$ samples, on a random (unknown) basis from one of the actual micro-times $\{\underline{t}_\mu\}$.

In other words, each and every macro experiment at time t_j will always randomly interact with the atomic electron somewhere in the time interval $\underline{t}_\mu$ to $\underline{t}_{\mu+1}$, which are unknown to all humans. Furthermore, attempts to replicate these experiments will sample atomic systems with different starting micro-times $\underline{t}_1$. In other words, the set of experimental times $\{t_j\}$ will **not** map to exactly the same single point in the micro-cycle.

$$\text{If } t_j \Rightarrow \underline{t}_\mu \;\&\; t_{j'} \Rightarrow \underline{t}_{\mu'} \text{ then there is no relationship between } \underline{t}_\mu \;\&\; \underline{t}_{\mu'}. \qquad \text{Equation – II.}$$

Thus, as QM assumed there are only averages (computed over sets of complete micro-periods) of observations that may be compared or considered to be "objective".

$$\therefore \; <A> \; = \; \sum_j \; <\Psi[t_j] \mid \mathbf{A} \mid \Psi[t_j]> \; = \; \sum_{jk} \; <\psi_j \mid \mathbf{A} \mid \psi_k> \; = \; \sum_{jk} a_k <\psi_j \mid \psi_k> \; = \; \sum_{jk} a_k \, \delta_{jk} \; = \; \sum_j a_j$$

Here, **A** is a QM operator (either an infinite matrix – Dirac/Heisenberg or a continuous, differential operator - Schrödinger), with complete orthonormal eigenfunctions $|\psi[t_j]>$; whereas a_j are Newtonian algebraic variables (or arithmetic numbers), which are identical to any of the classical (theoretical) values that may result from a **single** act of measurement. Thus, rather than assume that a single moment of time can be isolated in the laboratory that can be represented by a timeless equation, we will introduce explicit time delays (as in reality) in the mathematical representations:

So, instead of: $\mathbf{A} \mid \psi_k> \; = \; a_k \mid \psi_k>$ the fundamental equation becomes: $\mathbf{A} \mid \psi_k[t_j]> \; = \; a_k \mid \psi_k[t_j + \delta t]>$ Equation – III.

This new equation implies that there are **no** pure, timeless "states" involved in measurements but **only** state transitions.

During such an interval, an electron in the target atomic system exists on a straight-line segment of a trajectory, moving at a constant velocity $\underline{V}_\mu$ from a location $\underline{x}_\mu$ where an internal interaction occurred at time $\underline{t}_\mu$ to the next location $\underline{x}_{\mu+1}$ where another internal interaction occurred at time $\underline{t}_{\mu+1}$. As we will show in the model of the hydrogen atom later [7], the dynamics of the orbital electrons are defined by the atomic interaction cycle or protonic chronon, τ_P . These micro co-ordinates are defined here (classically) by:

$$\underline{t}_\mu \; = \; \underline{t}_1 + (\mu - 1)\tau_P \quad \& \quad \underline{x}_{\mu+1} \; = \; \underline{x}_\mu + \underline{V}_\mu \, \tau_P \qquad \{\mu = 1, 2, \ldots, N\}$$

3.1.2.3 ATOMIC MICRO-STATES

In the present theory (UET), an atomic electron only naturally changes its velocity $\underline{V}[t]$ at an internal interaction node $\underline{t} = \underline{t}_\mu$ when it actually participates in the protonic impulse, $\Delta\underline{I}^P[\underline{t}_\mu]$, that causes a change in its momentum $\underline{P}[t]$ and is defined (radially) by:

$$\Delta\underline{I}^P[\underline{t}_\mu] \; = \; m \, \Diamond\underline{V}[\underline{t}_\mu] \; = \; m \, \{\underline{V}[\underline{t}_\mu + \delta t] - \underline{V}[\underline{t}_\mu - \delta t]\} \; = \; m \, (\underline{V}_\mu^{\,+} - \underline{V}_\mu^{\,-}) \quad \& \quad \text{at atomic distances: } \Delta\underline{I}^P[\underline{t}_\mu] = h/2 \; \{\underline{x}[\underline{t}_\mu] \,/\, |\, \underline{x}[\underline{t}_\mu] \,|\}$$

The connection between these two views occurs if we assume that the **micro-states** correspond to micro-intervals from 'pure' times (existing in our imaginations) from a time $\underline{t}_\mu^{\,+}$ to a time $\underline{t}_{\mu+1}^{\,-}$ (i.e. $\underline{t}_\mu + \delta t$ to $\underline{t}_{\mu+1} - \delta t$) where δt is a tiny, finite time less than one chronon. Only the electron's momentum is 'detectable' through measurements of its energy transitions; this is acceptable because in our digital atomic model (elaborated in the next paper), the electron **exists** for most of its time in states of constant speed $\{V_n\}$ with only its direction being changed at each of the interaction events at times $\{t_j\}$.

Thus, the μ^{th} part ('segment') of a complete trajectory, between the event at time $\underline{t}_\mu$ and its next event at time $\underline{t}_{\mu+1}$ is characterized by its kinetic energy K_n (or its speed V_n). Thus, the atom's physical state (or μ^{th} micro-state) may be designated as: $|\psi_n[\underline{t}_\mu]>>$.

So, if two measurements result in two interactions on an electron, while in the same state, there will be minimal change in the electron's velocity ("wobble") as individual remote interactions only exchange a tiny amount of momentum. Significant differences ("the quantum effects") will only occur if the two interactions occur 'around' an internal, interaction node. In order for these two theories (QM and UET) to agree on the results of a series of "similar" measurements (while admitting that the micro interaction times $\{\underline{t}_\mu\}$ are never measurable by humans, without disrupting the original atomic systems) then there must be a relationship between their equations; the simplest hypothesis is to assume that the QM states $|\psi_k[t_j]>$ are linearly related (through a timeless constant γ) to **one** of the ideal (or classical) micro-states $|\psi[\underline{t}_\mu]>>$.

$$\text{Linear hypothesis: } \; |\psi_k[t_j]> \; = \; \gamma \; |\psi[\underline{t}_\mu]>> \quad \text{NB Double-ket notation for real micro-states}$$

We can do no better here than paraphrase Dirac, when faced with his "classical analogy", and say that [18] for "*the theory to agree with experiment*" then the constant must take on the value: $\gamma = 1/\, i\, \pi$. Plausibly, we might suggest that the factor i appears here to reflect the temporal shifts introduced by measurement (as per equation III above), while the π factor appears because the micro-theory here obeys Newton's laws of motion, resulting in **recti-linear** motion, while the QM theory (and Bohr) posit a continuously **curved** motion, especially for models of angular momentum, reflecting the continuous 'force' assumption.

Thus, the **fundamental** quantum mapping equation here establishing the link between **pairs** of canonical variables Q and P in both theories becomes:

$$\text{Micro-Mapping:} \quad \mathbf{Q\,P}\,|\,\psi_k[t_j]> \;=\; (1/\, i\,\pi)\; Q[\underline{t}_\mu+\delta t]\; P[\underline{t}_\mu]\,|\,\psi[\underline{t}_\mu]>> \qquad \text{Equation - IV.}$$

Taking the canonical co-ordinate Q to be the location $\underline{X}$ of the electron, as it moves along its micro trajectory around the atom, then, using Dirac's quantum commutator rule and focusing on the times 'around' a **single** interaction node $\underline{t}_\mu$:

$$[\mathbf{X},\,\mathbf{P}]\,|\,\psi_k[t_j]> = i\,(h/2\pi)\,|\,\psi_k[t_j]> = (\mathbf{X\,P - P\,X})\,|\,\psi_k[t_j]> = (1/\, i\,\pi)\;\{\underline{X}[\underline{t}_\mu+\delta t]\;\underline{P}[\underline{t}_\mu-\delta t] - \underline{P}[\underline{t}_\mu+\delta t]\;\underline{X}[\underline{t}_\mu-\delta t]\}\,|\,\psi[\underline{t}_\mu]>>$$

$$= -\,(m/\, i\,\pi)\; X_\mu\,(\underline{V}_\mu^{\,+} - \underline{V}_\mu^{\,-})\,|\,\psi[\underline{t}_{\mu+1}]>> \;=\; (i\,m/\,\pi)\; X_\mu\;\Diamond\underline{V}[\underline{t}_\mu]\,|\,\psi[\underline{t}_{\mu+1}]>>$$

$$= (i/\,\pi)\; X_\mu\;\Delta I^p[\underline{t}_\mu]\,|\,\psi[\underline{t}_{\mu+1}]>> = (i\,h/2\pi)\,|\,\psi[\underline{t}_{\mu+1}]>> \;=\; i\,(h/2\pi)\,|\,\psi_j[t_j]> \qquad \text{as } \underline{X}[\underline{t}_\mu\pm\delta t] \;=\; \underline{X}[\underline{t}_\mu] \;\equiv\; \underline{X}_\mu$$

$$\therefore\; <[\mathbf{X},\,\mathbf{P}]> \;=\; \sum_{jk} <\psi_j\,|\,\mathbf{A}\,|\,\psi_k> \;= i\,(h/2\pi)\sum_{jk} <\psi_j\,|\,\psi_k> \;=\; i\,(h/2\pi)\sum_{jk} <<\psi_j[\underline{t}_\mu]\,|\,\psi_k[\underline{t}_{\mu+1}]>> \;=\; i\,(h/2\pi)$$

Since this mapping is consistent between the two theories and QM itself reduces to a Quantum Rule (à la Dirac – see above) and an interpretation of the Hilbert Vector mathematics in terms of statistical averages of measures, then the new theory may be viewed as a **deeper**, model of reality than QM. At this time, there appears absolutely no way for a macroscopic set of electrons (i.e. a human-scale measuring instrument) to interact distinctly with one electron in an atomic system on a time scale less than or equal to the micro-interaction times $\{\underline{t}_\mu\}$. Thus, the present theory will not predict any different measurable effects than the existing QM theory but it does provide a realistic **picture** of electron dynamics that is consistent with human experiences of macro-scale interactions, which are also described adequately by Newton's Laws. History shows that visualizable imagery provides valuable future insights in physics.

The present model makes a clear distinction between an ontological view (admittedly only in our imaginations) and the epistemological view of atomics systems where results are conveyed directly to human senses by (long) chains of electron-to-electron interactions. The confusions and paradoxes of QM thus arise from conjoining these two sets of mental images. The price of this new model is that Maxwell's field mathematics of electromagnetic interactions must be restricted to laboratory scale experiments (which were actually the source of Maxwell's original inspirations) and a new discrete or quantized impulse model of electron interactions, involving the Gauss/Weber asynchronous hypothesis, be substituted. This also implies that future mathematical investigations of the atomic world be represented by discrete mathematics and not the infinitesimal (continuum) mathematics that has had nearly 300 years to demonstrate its appropriateness in the natural world and has only reached a research 'dead-end' at the atomic scale.

3.2 THE GENERIC MEASUREMENT MODEL

3.2.1 INTRODUCTION

This section will analyze a generic approach to measurements and probability theory that will hopefully shed some new light on a key component of quantum mechanics (QM) by distinguishing existence (ontology) and knowledge (epistemology). The situations are obviously **artificial** but have the benefit of being completely classical (understandable) and clearly separate the reality from our explicit knowledge (language) of the situation.

3.2.2 KNOWLEDGE AND MEASUREMENTS

Scientific knowledge is only gained from observations on systems, which are regarded as 'real'; i.e. examples of material reality that have existence and qualities and behaviors that are independent of such observations. If some observations involve quantities, they are called "measurements" and the resulting knowledge may then be expressed in terms of arithmetic numbers, expressed as multiples of (arbitrary) physical units. If such observations can be repeated (perhaps by other observers) then these results may be presented as a range of 'objective' numbers, to express our confidence in the accuracy of such measurements.

3.2.2.1 QUANTUM STATE AND ATOMIC MICRO-STATES

The discussion so far suggests that there is a deep connection between our atomic micro-states $|\alpha\colon \psi_n[t_j]>$ and the eigenfunction of quantum mechanics $|\Psi_n\{\underline{x};t\}>>$ (or Schrödinger's State function), seen here as a generator of statistical measurements [see §3.3].

3.2.3 QUALITATIVE OBSERVATIONS

Consider the following situation involving two special people: a character called **R**on, who picks coins from a hat [**R** = reality] and a second individual, called **B**ob, who has become blind [**B** = blind]. We are interested in the knowledge of the results of coin-picking by Ron that become 'known' to Bob. The coins are colored (on **both** sides): either black (B) or white (W) but never both; i.e. never chequered. After each selection is made, the coin is returned to the hat. Once extracted randomly from the hat, Ron always sees the coin selected. Bob may then ask a question, such as: "Is the color black?" and Ron answers truthfully either 'yes' or 'no'. These questions represent Bob's attempt to gain knowledge of the situation – they are **his** personal 'observations'. Ron's answers to these questions define Bob's complete knowledge of the experiments. Assume the hat is first loaded with b black coins and w white coins.

Since Ron selects without looking then the probability that Ron selects a black coin is $\mathscr{P}[B] = b / (b+w)$ and for a white one $\mathscr{P}[W] = w / (b+w)$ where probabilities are defined by the results of large numbers of repeated and similar tests. Mathematically, we always have: $\mathscr{P}[B] + \mathscr{P}[W] = 1$. If Bob has to **guess** the results of a given trial before the question is asked, then he would be best advised to use these probabilities, especially if he has been told the values of b and w. These two individuals represent the two aspects of our own nature: Ron represents our sensory apparatus (eyes, fingers, direct process), while Bob represents our higher mental faculties that may be communicated to other humans through language etc.

3.2.3.1 DOUBLE OBSERVATIONS

If, after extracting a coin, Ron also flips the coin so it lands either face up (U) or face down (D), then Bob can also ask: "Is it facing up?". If the flips are random and independent of their color then Pascal's assumption seems appropriate and we can assume that: $\mathscr{P}[U] = \mathscr{P}[D] = ½$. So, if Bob had to guess the likely number of black coins landing face up in a set of N similar trials, he would calculate: $\mathscr{N}[B \,\&\, U] = N * \mathscr{P}[B \,\&\, U] = N * \mathscr{P}[B] * \mathscr{P}[U] = N\, b / 2\,(b+w)$. Here, the symbol & is always used to represent the logical concept 'and' or more realistically here (temporally) 'and then'.

3.2.4 STATES AND VECTOR SPACES

Let the n^{th} trial of this arrangement be represented by the vector $|n\rangle$. This corresponds to the situation just before Bob asks Ron about the results; we can call this the **state** of the system. Let **Q** represent the quality being interrogated (e.g. color or face) with the results drawn from the pair of values $\{q_1, q_2\}$. Thus, if **Q** represents the color test (**C**) then {B,W} represent the range of values, while in the flip test (**F**) then {U,D} represent the range of values. So, by interpreting **Q** as a vector operator, corresponding to Ron checking the results, the tests can be represented mathematically as an eigenvalue equation:

$$\mathbf{Q}\,|n, k\rangle = q_k\,|n, k\rangle \qquad \text{where k represents } \mathbf{C} \text{ or } \mathbf{F}.$$

We now introduce a 'dual' vector space $\langle n|$ to represent Bob's act of discovering the values found in the n^{th} trial. These dual vector spaces are related to the primary vector space by using the adjoint transform (†), as algebraic products can then result in real (arithmetic) numbers.

$$(\langle n,k|\,\mathbf{Q}^{\dagger})^{\dagger} = \mathbf{Q}\,|n, k\rangle \quad \text{since self-adjoint: } (\mathbf{Q}^{\dagger})^{\dagger} = \mathbf{Q} \;\;\&\;\; (q_k)^{\dagger} = q_k{}^{*} = q_k \text{ (real)}$$

For example, if Ron discovers the result of the n^{th} selection is a black coin i.e. $|B,n\rangle$ or $\mathbf{C}\,|B, n\rangle = B\,|B, n\rangle$.

So, when Bob asks: "Is this result black?" : $\langle B, n\,?|$ or $\langle B, n|$ {dropping ?} i.e. $(\mathbf{C}\,|\,B, n\rangle)^{\dagger} = \langle B, n|$

If we now represent the logic of this trial numerically so that if Bob asks the correct question by the number 1 (true) and the incorrect question by 0 (false) then: $\langle B, n|B, n\rangle = \langle W, n|W, n\rangle = 1$ & $\langle B, n|W, n\rangle = 0$

Using the discrete Kronecker delta symbol δ_{jk} {which is 1 if j=k or 0 if $j \neq k$} then all 4 results can be represented by:

$$\langle q_j, n|\, q_k, n\rangle = \delta_{jk}$$

So, all the possible n^{th} trial results can be summarized as: $\langle q_j, n|\,\mathbf{Q}\,|q_k, n\rangle = q_k\,\delta_{jk}$

3.2.4.1 AVERAGE RESULTS

The color state of the n^{th} trial must be either black **or** white but never both (i.e. exclusive or B.XOR.W). These two **exclusive** states may be represented through use of the square root of minus one; i.e. $i \equiv \sqrt{-1}$.

$$|\,C, n\rangle = |B, n\rangle + i\,|W,n\rangle \qquad \text{the choice of the real value is arbitrary.}$$

Thus, the result of Ron's observation is either the real or the imaginary component but not both. Then, Bob's generalized color question ("What color is the nth trial?") can be represented mathematically as:

$$< C, n\ ? \mid \ = \ < B, n \mid \ - \ i < W, n \mid \qquad \text{remembering adjoint invokes complex conjugate.}$$

Finally, we will symbolically represent Bob's knowledge of the color of the n^{th} trial by c_n.

$$\therefore \ c_n \ = \ < C, n\ ? \mid \mathbf{C} \mid C, n> \ = \ (< B, n \mid \ - \ i < W, n \mid) \ (B|B, n> \ + \ i \ W \ |W,n>) \ = \ B + W$$

So, Bob only knows that the color of this trial is always black xor white. Thus, the + symbol represents 'exclusive or'.

Each **set** of N trials is labeled by an identification number r {r =1, 2, …}, so that any individual trial from the total set of Nr trials can be identified by two unique integers r and n; producing a 2 dimensional state vector |C, r; n>. Thus, the color result of the n^{th} random trial #n in experimental sequence r will sometimes be |B, r ; n> and sometimes |W, r ; n>. We can represent these uncertainties by the two arrays (or matrices) of numbers b_{rn} and w_{rn}, giving:

$$|C, r\ ; n> \ = \ b_{rn} \ |B, r\ ; n> + i \ w_{rn} \ |W, r\ ; n>$$

Bob knows with certainty that any result must be either black or white; this certainty being represented by unity.

$$\therefore \ <C, r\ ; n\ ? \ |C, r\ ; n> \ = \ b_{rn}^{\,2} + \ w_{rn}^{\,2} = \ 1$$

Bob also knows that he is totally ignorant about the n^{th} color trial if he only asks about the k^{th} result; this total ignorance is represented (numerically) by the value zero.

$$\therefore \ <C, r\ ; k? \ |C, r\ ; n> \ = \ 0 \quad \{\text{if } k \neq n\}. \qquad \text{Or, in summary: } <C, r\ ; k? \ |C, r\ ; n> \ = \ \delta_{kn}$$

Bob's best guess for trial# r;n is:

$$c_{rn} \ = \ < C, r\ ; n\ ? \mid \mathbf{C} \mid C, r\ ; n> \ = \ \{< B, n \mid \ - \ i < W, n \mid \} \{b_{rn} \ |B, r\ ; n> + i \ w_{rn} \ |W, r\ ; n> \} \ = \ b_{rn}^{\,2} \ B \ + \ w_{rn}^{\,2} \ W$$

We can also define the mathematical average (most likely value) from N trials as: $<C> \ = \ (1/N) \sum^{N}_{n} c_{rn} \quad \{\text{any r}\}.$

$$\therefore \ <C> \ = \ B \ \mathscr{P}[B] \ + \ W \ \mathscr{P}[W] \quad \text{where} \ \ \mathscr{P}[B] \ = \ (1/N) \sum^{N}_{n} b_{rn}^{\,2} \ \ \& \ \ \mathscr{P}[W] \ = \ (1/N) \sum^{N}_{k} w_{rn}^{\,2}$$

Now, $b_{rn} = <B, r\ ; n| \ C, r\ ; n> \ , \ w_{rn} = <W, r\ ; n| \ C, r\ ; n> \ \ \therefore \ |C, r\ ; n> = <B, r\ ;n| \ C, r;n>|B, r;n> + i <W, r;n| \ C, r;n> \ |W, r;n>$

$\therefore \ |C, r;n> = |B, r;n> <B, r;n| \ |C, r;n> + |W, r;n> <W, r;n| \ |C, r;n> \ \therefore \ |B, r;n> <B, r;n| + |W, r;n> <W, r;n| \ = \ \mathbf{I}$ {unit matrix}

Thus, the set $\{\mathbf{I}, \mathbf{B}_r \ = |B, r> <B, r| \ , \mathbf{W}_r = |W, r> <W, r| \ \}$ form a **group** – the operations required for knowing about this coin test.

3.2.5 MULTIPLE QUALITIES

We can generalize this coin-picking and tossing situation to any system having multiple qualities, designated symbolically as Q & P; each with multiple possible values taken from the discrete sets $\{q_k\}$ and $\{p_k\}$, as eigenvalue equations:

$$\mathbf{Q} \ |q_k\ ; n> \ = \ q_k | \ q_k\ ; n> \quad , \quad \mathbf{P} \ |p_k\ ; n> \ = \ p_k | \ p_k\ ; n>$$

3.2.5.1 INDEPENDENT QUALITIES

Whenever these two qualities **and** tests are **independent** of one another (e.g. color and flipping) then their eigenvectors are separable and may be combined into a larger, single vector space; i.e. $| \ q_k\ ; n> \ |p_k\ ; n> \ = \ | \ q_k\ , p_k\ ; n>$

These expanded vectors are completely orthogonal, satisfying: $< q_i\ , p_k\ ; m \mid q_j\ , p_l\ ; n> \ = \ \delta_{ij} \ \delta_{kl} \ \delta_{mn}$

There are two possible results for combining tests: '&' for if-then plus ':' for either one but not both (.xor.).

Thus:

AND	$< q_i\ , p_k\ ; n \mid (\mathbf{P} \ \& \ \mathbf{Q}) \mid q_i\ , p_k\ ; n> \ = \ q_i \ \& \ p_k$
XOR	$< q_i\ , p_k\ ; n \mid (\mathbf{P} \ : \ \mathbf{Q}) \mid q_i\ , p_k\ ; n> \ = \ q_i \ : \ p_k$

3.2.5.2 DEPENDENT QUALITIES

The previous results are only valid when the results of one trial do **not** bias the next trial; this has always been the deep assumption underlying classical mechanics, where **visual** observations do not affect large (macro-scale) objects. This is not the case in QM, especially where electrons are involved and external measurements are comparable (or larger) than the intra-electron interactions occurring in atomic systems. This is recognized explicitly in UET, where 'light' is viewed as the actual electro-magnetic interactions between remote electrons. The following analyses again builds on some biased classical experiments to provide insights into such strongly coupled (disrupted) systems of measurement.

Now, imagine a third person (Max) secretly joining the game; he rigs the experimental environment in three different ways.

a) Max sets up two different (but apparently similar) hats, with different ratios of black and white coins & gives (realist) Ron a different hat each time, so then Bob gets really confused by Ron's series of inconsistent answers, as discovered by calculating the average black/white ratios from similar series of trials. The physical analogy here is that Max plays the role of other remote electrons that prevent the experiment being identical on all occasions.

b) Max randomly illuminates the selected coin with a UV light that switches its color, so that a white coin now appears black to Ron (and vice-versa) so that Bob is given the incorrect color information but Ron can still say whether Bob was right. This situation might occur in an atom where the experimenter measures the energy of an atom when it disturbed by the act of measurement itself, so that the original (undisturbed energy level) remain unknown to all humans.

c) Max waits to see what color is selected and only if it is black does he turn on an electromagnet to influence which side the coin will land on, biasing the choice to face up, generating an unequal distribution of face up and face down 'flips'.

This latter situation may well be the case when an experiment tries to correlate the spread of position results with the spread of momentum results as measuring momentum requires the measurement of two consecutive positions first before then measuring a final location. During each finite time between any of these three position measurements, other (undetected) electrons may exchange unknown quantities of momentum with the target electron producing Heisenberg's Uncertainty fluctuations. Admittedly, these specially biased experiments were constructed to throw confusion into the experimental setup but they do illustrate the many unspoken assumptions that often underlie our quantum measurements, such as locality, isolated systems, repeatability, etc.

3.2.6 EXISTENCE

The most fundamental observation is the agreement between humans that a specific object **exists** [19]. When several **distinct** examples of similar objects are examined then a **concept** may be invented to characterize the whole **set** of such objects. The idea underlying the concept may be illustrated by selecting **examples** of such a concept and allowing the observer to intuit the **meaning** of the concept; this seems the way that young children become aware of concepts, especially when the new concept is assigned a unique **name** (or sound) within a cultural or language group. As greater language skills develop, then a person may be exposed to a cultural attempt to assign a verbal description of the common **properties** of the objects assigned to a concept; this is the origin of **semantics**, where verbal symbols are recursively used to define verbal concepts. When **finite** groups of different objects are examined then the concept of a **set** itself may be introduced. Through a process of further abstraction, some properties of two distinct sets then may be seen to be shared, while others are ignored in a mental process known as **abstraction**. This allows examples of sets to be combined into larger sets to form conceptual hierarchies. Additionally, all finite sets of persistent, stable, distinct objects may be found to possess the common property of **number** with diverse sets sharing the result of counting the distinct examples in the set. This appears to be the origin of the second-order concept of **arithmetic**. The rules of arithmetic may be reduced to rules for manipulating the two foundational numbers: zero and one, where zero is the failed result to count a set with no members (the empty set), while one is the result of adding one example to any empty set. Thus, it can be seen that this binary approach is critically dependent on our concept of physical **existence**. Real material objects (things) either exist **or** do not exist. Since this appears to be a foundational feature of our use of language, it appears to offer a common approach to all of reality that this style of thinking (verbalization) be applied to **all** scales of reality. Just as it is useful to be able to answer the question: "Is there a rock here?" it also becomes useful to be able to pose the same question about the smallest examples of physical reality, such as: "Is there an electron here?" The major problem then is that our unaided senses have evolved to readily answer this type of question only for macroscopic objects, even when we cannot actually touch them by relying on our most powerful sense – vision. Unfortunately, electrons are the source of light, so we cannot simply rely on sight to answer questions about the existence of electrons directly. We must build technologies that can interact with electrons that respond differentially when interacting or not interacting with an electron. Since an electron must interact with another electron to qualify for existence-status (i.e. be considered '**real**') then any test to determine an electron's existence must involve an **interaction**, then all existence tests must disturb any electron.

A key part of the materialist schema of the world is the foundational principle, called here: the **Persistence of Existence** (*PoE*). Even infants mostly accept that an object continues to exist when it temporarily disappears from their view through the well-known game of "Peek-a-Boo". Thus, the metaphysical hypothesis that electrons are foundational material objects is to also accept the *PoE*. Therefore, it is both logical and consistent to categorize them as '**particles**' with an implied unique location in space at all times.

It is critical to realize that the concept of waves does not include any *PoE* as real waves dissipate over time, particularly when local excitations merge back into the global medium that supports any wave-like disturbance. Another characteristic property of a material particle is that its mass, *m* persists. This awareness was one of the reasons that Dirac grounded his approach to quantum mechanics [16] with the '**classical analogy**', viewing the electron as a point-particle with an invariant mass and unique spatial location $\{\underline{x}(t)\}$ plus he accepted Newton's definition of instantaneous velocity, $\underline{V}(t)$, at every unique time, t, so that he continued to use the basic classical concepts of (instantaneous) linear momentum, $\underline{P}(t) = m\ \underline{V}(t)$, angular momentum, $\underline{L}(t) = \underline{x}(t) \wedge \underline{P}(t)$ and Leibniz's kinetic energy, $K(t) = \underline{P}(t) \bullet \underline{P}(t)/2m$. This comprehensive approach was not even followed by Bohm in his massive text on quantum theory [20], where in attempting to justify the standard QM approach to wave mechanics, he readily accepts the usage of concepts such as mass and instantaneous momentum although neither apply to **massless** waves, while admitting that even the concept of velocity no longer applies in QM [21] but that did not present him a problem as he can rely on the mathematical definition of a continuous derivative [22], even though these are never "measurable". Indeed, the illogicality and self-contradictions pile up as the classical picture of a point particle for an electron is discarded **after** the classical Hamiltonian model of a particle, subject to a spatial potential, is used as the starting point for all the QM models of the hydrogen atom based on wave mechanics before being 'converted' to Schrödinger's Equation using the de Broglie transformation between its particle momentum and wave-number but more insidiously into its linear operator equivalent [23].

Therefore, it should be a goal of any quantum theory of micro-reality to use only basic concepts that non-scientists can understand, so that our scientific theories may become acceptable to the vast numbers of these citizens, who end up funding scientific research. Thus, as a "**particle**" is only defined as a "small, localized quantity of matter" then our quantum theory need only retain the necessary properties of existence, mass and location (we will also add intrinsic electric charge, *e*) to link this image to the electron. There is no implication of color or size (volume) – contra Descartes. Nor, indeed, should the idea of self-rotation ("spin") be invoked, which implies a finite size. Viewing the electron then as a foundational component particle of all matter to explain the observable features of macro collections of matter. Nonetheless, we can represent the existence of a specific object by a similar symbolic vector-space scheme, where $|A: \underline{x}; t\rangle$ represents the reality of the existence of one object of type A at the (relative) location, identified as $\underline{x}$ at a relative time t. We introduce the symbol $\boldsymbol{\mathcal{E}}$ to represent the reality of the actual existence of such any object anywhere. This becomes an eigenvalue equation if we assign the number one to a confirmatory result, with the number zero otherwise (non-existence).
Algebraically: $\boldsymbol{\mathcal{E}}\,|A: \underline{x}; t\rangle = \varepsilon\,|A: \underline{x}; t\rangle$ where $\varepsilon = 1$ if anything exists there and 0 if nothing exists there, at time t.

This scheme can be cast in a measurement/frequency-probability mode by repeating the reality test on N occasions (at times t_n) at the same location to provide a measure of existence or probability $\mathscr{P}[A: \underline{x}]$ and ε_n signifies the human existence of the target object.

Probability: $\mathscr{P}[A: \underline{x}] = 1/N \sum^N_n \boldsymbol{\mathcal{E}}\,|A: \underline{x}; t_n\rangle = 1/N \sum^N_n \varepsilon_n\,|A: \underline{x}; t\rangle = 1/N \sum^N_n \varepsilon_n$

Thus, if a reality test can be repeated for a large number of times (i.e. $N \rightarrow \infty$) then $\mathscr{P}$ represents our confidence in finding an object at that location at any time, so that the 'real' number range $\{0, \ldots, 1.0\}$ represents our knowledge from ignorance to certainty.

3.2.7 CONTINUOUS VARIABLES

Discrete binary values can be extended to pseudo-continuum variables, such as position, by dividing a finite range R into K discrete equal values of size r, where usually R is very much larger than r (i.e. R >> r).

3.2.7.1 SPATIAL SEPARATIONS

In the case of spatial separations (or lengths from an observer), space R can be divided into K **equal** segments, each of length δx and numbered serially from the distance from the observer, using an integer index k, defining a set of K special points $\{x_k$, with k = 1, 2, … , K}; often K is vastly too large to be countable.

$$\therefore\ \delta x = R/K = x_{k+1} - x_k \qquad \therefore\ x_k = k\,\delta x = (k/K)\,R$$

Thus, the experiment to determine an object's position at a given time (say t_n) is really a set of existence questions about which segment k is the object's centre of mass (or the whole object if its size is less than δx and it must be totally in only one segment). Thus, $\boldsymbol{\mathcal{E}}\,|A: x_k ; t_n\rangle = |A: x_k ; t_n\rangle$ represents the reality that the object A actually is located in segment k at time t_n.

So, the question: Does the object A exist in segment k, at t_n becomes symbolically: $(\boldsymbol{\mathcal{E}}\,|A: x_k; t\rangle)^\dagger$.

The concept of a particle implies that such an object can **only** exist at one segment at any one moment of time, this can be readily represented by the scalar product of two state vectors for the same object, which are chosen to be orthonormal.

$$\langle A: x_j ; t_m | \mathcal{E} | A: x_k ; t_n \rangle = \delta_{jk}\, \delta_{mn} \quad \{\text{consistent with the equation: } \mathcal{E}^2 = 0 \text{ or } 1\}$$

This strongly suggests that the classical approach for having an algebraic variable, like X, to represent the location of an object needs, when extended the micro-world, to explicitly include the existence operator; i.e. the question "Where is the object, A?" consists of two parts: [Does the object A exist? - $\mathcal{E}$] and [**In** which segment does it exist at a specific time? - $\mathcal{X}$]; or represent **X** by $\mathcal{X}\mathcal{E}$. Explicitly, the use of the binary existence operator, $\mathcal{E}$ is an **alternative** to replacing algebraic variables with linear operators, as is usual in QM.

Location Question: $\mathbf{X}\,|A : x_k ; t_n\rangle = \mathcal{X}\,\mathcal{E}\,|A : x_k ; t_n\rangle = \varepsilon_n\, \mathcal{X}\,|A: x_k\rangle = \varepsilon_n\, x_k\, |A: x_k\rangle = x_k\, |A: x_k\rangle \quad \{\text{if } \varepsilon_n = 1\}$

$0 \quad \{\text{if } \varepsilon_n = 0\}$

Since: $\mathcal{X}\,|A: x_k\rangle = x_k\,|A: x_k\rangle$ when A exists in segment k.

If we let |A: X[t]> represent the **unknown** position of an electron at time t then standard QM is based on assuming that results for averages (or expected values) imply statistical variations for each single measurement, with the philosophical implication that there are no objects with unique properties waiting to be revealed. This is not the case in UET, where it is denied that an identical experimental arrangement is ever possible; external variations will always occur so that repeating an experiment selects out a slightly different value **each** time.

QM: $|A: X[t]\rangle = \sum^{N}_{k} a_k\, |A : x_k ; t\rangle$ UET: $|A: X[t]\rangle = \sum^{N}_{n} a_n\, |A : x_n ; t_n\rangle$ both: $\mathcal{X}\,|A: x_k\rangle = x_k\,|A: x_k\rangle$

3.2.7.2 VELOCITY VARIATIONS

Central to the medieval notion of motion was the idea of speed: how fast an object was moving relative to a fixed observer. It was soon recognized that this idea implied a direction of motion (or velocity) as space was conceived as having three independent axes. Newton constructed his worldview around his radical concept of **momentum** by combining two properties of an object: its velocity (speed in a given direction) and its inertial mass (ability to resist changes in its motion). Newton imaginatively used DesCartes' new algebraic notation to create a mathematical definition [24] of momentum P as the algebraic product of its inertial mass M and its velocity V (speed in a given direction); thus: P = M V. Now, the idea of speed invoked a simple ratio: how far (across space) does the object move in a unit of time; mathematically, if the object was at (relative) position x_1 at the time t_1 and moved to a new position x_2 at a time t_2 then its velocity V here was defined as: $V[x_1, x_2] \equiv (x_2 - x_1) / (t_2 - t_1)$. Using finite differences, $\Delta x \equiv x_2 - x_1$ and $\Delta t = t_2 - t_1$ this can be rewritten as: $V[x_1, \Delta x] = \Delta x / \Delta t$. Newton's great simplification was the mathematical assumption that finite differences (like Δt) could be made **vanishingly small**, a radical step - deeply resisted by Conservative intellectuals, as told in [25]. This led to the critical idea of **instantaneous velocity** that was defined at only any **one** point, x: V[x]. Although, this has been given the mathematical image of a tangent to a curve of position plotted against time, it has **no** experimental analogue – certainly at the level of the atom. In fact, the whole of Classical Mechanics (CM) is constructed around these unchallenged assumptions. Indeed, appealing to the universal human experience of viewing a macroscopic object, without altering its motion, CM imagined that it was always possible to make two measurements of an object's position, so close together in time (i.e. $\Delta t \rightarrow 0$), that a particle's position (X) and instantaneous velocity or momentum (P) can both be measured with unlimited precision. In the nineteenth century, this led to Lagrangian continuum mechanics and Hamiltonian particle dynamics [26] – both using differential equations centered on complementary (or 'canonical') pairs of variables {X, P}. UET continues to use Newton's particle model but the focus is now centered on **finite** interactions between **finite** objects, NOT continuous forces (like gravity) that create the tiniest of non-measurable changes. UET is now proposed as a modified version of real, finite difference mechanics where irreducible effects are always generated between the smallest examples of real, material objects, i.e. electrons. Now, time is viewed as the critical dimension, so that **NO** two canonical variables (e.g. X, P with overlapping definitions) can ever be measured simultaneously. This realist program means that wave concepts need **only** be viewed as no more than imaginative, **mathematical** (never physical) constructions.

3.2.8 ELECTRONIC MOMENTUM

In measuring the **existence** of an electron, it is logically necessary for some (at least one) other electron to interact with the target electron – otherwise the rest of reality would be indifferent to its existence or not. Thus, every measurement occurs at the expense of the activities of the target electron that **would** have happened if **no** interaction had occurred. Therefore, in order to measure the properties of all the electrons in a system at a single point in time (relative to an external observer) requires external interventions with **all** the component electrons in the target system – this introduces a maximal, disruptive, discontinuity in the series of interactions that would have occurred without the measurement. The result of an interaction **M** on a system that was in the state $|Q : t\rangle$ at a time t before the measurement is to thrust it into state $|Q' : t + \Delta t\rangle$ afterwards. In UET, the Saturation Hypothesis implies that Δt must be at least one electron interaction-cycle (chronon) τ. Therefore, the impact of measurements on a system may be contrasted between traditional QM and UET, as follows:

QM: $\mathbf{M}\,|Q : t\rangle = m\,|Q : t\rangle$ UET: $\mathbf{M}\,|Q : t\rangle = m\,|Q' : t + \tau\rangle \quad \{Q' \neq Q\}$

3.3 THE ALGEBRAIC MEASUREMENT MODEL

3.3.1 IDEALIZATION VERSUS REPETITION

The two level scheme proposed here [§2.1] makes a disjoint distinction between the mathematical-space $\mathcal{M}$ used to generate the measurement predictions, familiar to earlier QM theories, and the imaginary space $\mathcal{I}$ – a mathematical representation of the **real** world systems when they are isolated from other electrons in the universe ("**idealization**"). Random interactions between environmental electrons and laboratory electrons must be added back to transform $\mathcal{I}$ to $\mathcal{M}$. This theory will use the Hilbert vector space representation [27] in both $\mathcal{M}$ and $\mathcal{I}$ but symbolically they need to be visually distinguishable. Thus, a micro system S as viewed in $\mathcal{I}$-space will be represented by double-kets, such as: $|S>>$. When S is viewed in $\mathcal{M}$-space it will still use Dirac's single-ket representation $|S>$. Although $\mathcal{I}$ is our **image** of reality, (like Kant's *ding an sich*), $\mathcal{M}$ is the maximal or optimum model that humans can **use** to extract statistical information when interacting with a micro-system. The link between the two spaces and the reality of laboratory measurements is the **long-term** statistical average denoted <x> when experiments are attempting to measure the **system** property X that corresponds to the Hilbert operator **X**. Since the random, contextual interactions are assumed to average away (see later), then this "bridging concept" implies:

$$<x> = < S | \mathbf{X} | S > = << S | \mathbf{X} | S >>$$

Let there be N repeatable experiments, labeled by their laboratory start times t_n {n = 1, 2, ... , N} and let x_n be the value of X determined by the n^{th} experiment. Rather than superposition, UET now assumes that $|S>$ is linearly related to the idealized state $|S_n>>$ that corresponds to the n^{th} experiment via a set of complex, weighting factors W_n. $\therefore \; |S> = \sum_n W_n |S_n>>$

In the idealized mental-space, $\mathcal{I}$ the double-ket is also an eigenstate (or **micro-state** [see §3.1.2.3]) of **X** , so: $\mathbf{X} |S_n>> = x_n |S_n>>$

Since these double-kets are assumed to be orthonormal (different experiments or atoms), then: $<<S_j | S_k>> = \delta_{jk}$

$$\therefore \; <x> = < S | \mathbf{X} | S > = \sum_j W_j^* \sum_n W_n << S_j | \mathbf{X} | S_n >> = \sum_j W_j^* \sum_n W_n x_n << S_j | S_n >> = \sum_n W_n^* W_n x_n$$

This fits with the normal QM scheme [see §3.1.1], where long-term averages are weighted by frequency occurrence values $|W_n|^2$.

3.3.2 MEASUREMENTS

3.3.2.1 SUCCESSIVE MEASUREMENTS

The basic error, lurking behind the Uncertainty Principle, is the assumption that simultaneous measurements can be made of both canonical variables A and B, when in reality these must be performed serially in time with a minimum time separation of one chronon. Thus, either: $\mathbf{A}[t + \tau]\, \mathbf{B}[t]$ or $\mathbf{B}[t + \tau]\, \mathbf{A}[t]$. Critically, each measurement either changes the state or allows other interactions.

3.3.2.2 DISCRETE FOURIER TRANSFORMS

Standard QM always uses continuous Fourier transforms but the discrete nature of microscopic reality implies that a more appropriate technique would be **Discrete Fourier** transforms, which converts a finite list (N items) of equally spaced samples $\{x_n\}$ into a list of coefficients of complex sinusoids $\{X_k\}$, ordered by their frequencies, which are integer multiples of a base frequency $\upsilon_0 = 1/T_0$ where T_0 is the total length of the sampling duration. In effect, this is a conversion from the ordered time domain $\{t_n\}$ to the increasing frequency domain $\{k\, \upsilon_0\}$.

$$X_k = \sum_n x_n \exp[- i\, 2\, \pi\, k\, (n/N)] \quad \text{and} \quad x_n = \sum_k X_k \exp[+ i\, 2\, \pi\, n\, (k/N)]$$

Here, the functions, $u_k = \exp[+ i\, 2\, \pi\, k\, (n/N)]$ {for n = 0, 1, 2, ... , N – 1} form an orthogonal basis; such that:

$$u_k\, u_{k'}^* = \sum_n \exp[+ i\, 2\, \pi\, (k - k')(n/N)] = \delta_{kk'}$$

When the X_k are normalized, then: $\sum_n |X_n|^2 = 1$ or redefining: $|X_n|^2 = W_n \quad \therefore \quad \sum_n W_n = 1$

This has a very strong resemblance to the probability viewpoint of standard QM measurements [§3.1.1], implying discrete sampling.

3.3.2.3 INFERRED EXISTENCE

Discussions about the Uncertainty Principle (UP) assume that observations alone disrupt the target system [28] so that accurate data cannot be collected. This is not always so, as the following examples illustrate where this ignorance can be overcome when one knows the extent of the intervention. If a mugger only takes $20 every time he asks you how much is in your wallet or the IRS always takes 50% of your net wealth on December 31st then it is still meaningful to ask how much you had before the interventions.

Null results can also provide useful information, so that, for example, if your wallet was checked before starting down a shopping street then the same amount is still found in the wallet at the end of the street then we can infer that no mugging (or shopping) events occurred. This illustrates that it is ignorance in the initial conditions that generates ignorance in final results ("Laplacian Error"). In the case of closed orbits in atomic systems then if an electron arrives 'on time' (when the period is known) then we know that no interactions occurred during those orbits. Even more strongly, UET predicts that each remote intervention only alters the momentum by a very tiny amount $\Delta P = m\ b$, where b is the minimal electron speed quantum derived in this theory; see [29].

3.3.2.4 FIZEAU'S ELECTRON CHOPPER

It does not seem that a modified version of Fizeau's famous optical experiment of 1850 could not be replicated within a large Crooke's tube due to the much slower speeds of accelerated electrons. Two synchronized spinning wheels, each wheel consisting of two parallel surfaces with aligned parallel slits to minimize diffraction effects. The first wheel's slits allow the electrons to pass through (with an inferred location) could be subsequently detected on a second wheel containing only one pair of narrow detection slits. This would allow the velocity and inferred position of the electron to be determined at one time.

3.3.2.5 EXPLICIT MEASUREMENT MATH

The mathematical representation of QM measurements needs to explicitly include the following components:

1) The concept of existence (the exist operator $\exists$ and the discrete eigenvalues $\{0,1\}$ that lead to number results.
2) A clear distinction between the target electrons (S) and the measuring observer (O), who defines the reference frame.
3) A finite time (T_m) is needed to complete each individual measurement.
4) The finite delays needed to describe the EM interaction at the source/target (ΔT_s) and at the observer (ΔT_o).
5) Repeated measurements must involve different microscopic laboratory contexts; thus it is inherently statistical.
6) Repeated measurements target similar (but never identical) systems, contrary to the mathematical assumptions.

The core of all measurements must occur in our common Space and Time (i.e. the relative location of an electron, X_s compared with the location of the observer X_o). The traditional algebraic form of this location operator is very weak. In other words, the position eigenvalue equation is a poor starting point. $\mathbf{X}\,|t> = x[t]\,|t>$; better: $\mathbf{X} \Rightarrow (x_s \exists - x_o \exists)$. For a target electron to be 'measured' by an observer, they must interact; so they must be on each other's light-cone.

$$\text{i.e}\quad (x_s - x_o) = c\,(t_s - t_o)$$

The key idea is that the existence of an electron at a specific (singular) location is always **implicit** in the concept of a particle whether such a location can be assigned a unique numerical value (relative to a frame of reference) or not. This makes the idea of an electron's location at any moment of time an existential (or **ontological**) primitive concept. In contrast, although we can readily conceive of any particle moving between locations over time, the concept of velocity (and hence momentum) is a derived concept: requiring the difference between two existential events at two **different times**. Indeed, the very old idea of an instantaneous velocity is a mathematical idea that can never be achieved by humans, in **any** laboratory. It is ironic that this purely imaginary concept has migrated from abstract mathematics to the reality of physics that insists on experimental validation; worse, as momentum is seen as the complementary variable to location in the key concept of action, it has been promoted to a comparable status as location.

3.4 STATISTICAL INTERPRETATIONS

Schrödinger assumed that an electron in an atom could be represented by an oscillating charge **cloud** of electricity evolving constantly in space and time [30] according to his wave equation. He did not view the observed discrete spectral frequencies as being due to Heisenberg's "quantum jumps" but due to a resonance phenomena between these clouds. Born was dismissive of these interpretations but still recognized that the wave function ψ needed to be interpreted in terms of probability ideas. He decided that a definite probability corresponds to a "state in space"; this is determined by the de Broglie wave associated with the state. Born was convinced of the reality of this wave process that "guided" the mechanical process. He believed that where the amplitude of the guiding wave is zero at a certain point in space then the probability of finding the electron at this point is vanishingly small. These ideas were derived from his knowledge of light scattering by small particles. He was convinced that the experimental confirmations of such scattering, with the theoretical calculations, were sufficient grounds for the correctness of the principle of associating wave amplitude with the number of particles (or probability) [31]. Born proposed that if E_n is the energy and ψ_n the eigenfunction of such a state, then $\psi^*_n\psi_n\, d\nu$ is the probability will be found in the volume element $d\nu$; with this still being true even if such an experiment, if carried out, would destroy the connection with the atom altogether.

Even though Max Born correctly criticized Schrödinger's "cloud picture" he goes on to talk about a *density distribution* of the electron in the atom, or of an *electronic cloud* around the nucleus. By this, he means he means "*the distribution of charge which is found when we multiply the probability function for a definite state by the charge e of the electron*". Indeed, Born used this picture to explain why stationary states do not radiate, appealing to a semi-classical model of the electric dipole moment.

Nowhere, does he discuss the idea that the whole Hamiltonian equation is based on the classical model of a particle, where **all** the activity is only defined at **one** single point in space at **one** instant of time, where the Coulomb potential is concentrated on the total charge of the electron there. Physicists are just as likely as any one else to want to "*eat their cake and have it, too*". However, to be fair to Born, he did write in his magnum opus [32] that: "*The imagination can scarcely conceive of two ideas <wave and particle> which appear less capable of being united than these two, which the quantum theory proposed to bring into such close connexion*." Although Born later interprets the psi function as a "wave of probability" he fails to realize that the challenge here is not mathematical but ontological: the very nature of reality itself.

3.4.1 QUANTUM PROBABILITIES

Quantum situations are easiest to contrast with classical situations in the realm of predicting the probability of measured events. The prototypical classical probability events involve tossing symmetric objects, such as two-sided coins or six-sided dice. Ironically, these situations cannot be calculated by physicists, as they are far too delicate and complicated, so the theoretical results are computed assuming that all outcomes are equally likely, so that each possibility is simply added. When observations refute these predicted results, it is the objects that are criticized for not being "really" symmetrical or the 'tossing' that is faulty – never the theory. In the case of quantum outcomes, such as electrons crossing through a narrow, magnetized gap (e.g. the Stern-Gerlach experiment, where an electron beam is split into two halves) the observations are usually interpreted by assuming that electron spin behaves like a simple magnet, which interacts randomly in a binary fashion with the equipment magnet.

The quantum probability mathematics is extended by assuming that each one of the individual probabilities $\mathscr{P}_n[x,t]$ is assumed to be first represented [31] by the square modulus of the quantum wave $\psi_n[x,t]$ i.e. $\mathscr{P}_n = (\psi_n)^* \psi_n$. Here, ψ_n is just one of the possible wave solutions that is itself represented by the **two** parts of a complex number, e.g. A_n and B_n, called the probability amplitudes, $\psi_n = A_n + i\, B_n$. QM has created a theory of Nature on the bizarre mathematical idea of complex square roots. When calculating each possibility, by convention, these two components must be added first before they are multiplied together and then summed. What this analysis shows is that humans have to be very careful in deciding how to represent complex events. Clever mathematical tricks should be suspect or better yet, begin with clear physical ideas and then try to map these comprehensible ideas into known areas of mathematics (if possible). The heart of this whole mathematical theory switches from a particle-perspective of an electron existing at a specific location (x) at a given moment of time, t because these are the explicit implications of beginning the exposition with a mechanical point-particle model in the **Hamiltonian**. Then the de Broglie *magic* ("hypothesis") is invoked that transforms the momentum properties of the electron as particle into the diffuse features of a non-localized wave. No wonder QM finds itself on the horns of a dilemma: *localized particle or extended wave*? The only way these contradictions can be resolved is to interpret the wave as a probability abstraction: a technique for calculating how often an electron might be 'found' to be in a narrow volume of space at any time a measurement is made in a 'similar' situation. This **probability viewpoint** has been accepted by most physicists but **not** by the originators of wave mechanics, such as de Broglie and Schrödinger, who saw the electron wave as **real** as any classical wave.

4. SUMMARY AND CONCLUSIONS

In this final section, the results and conclusions from this paper will be briefly summarized in order to draw out the major implications from the material. The paper concludes with summaries of the future papers in this programme. We will let the comparison of the analytic predictions of this theory with experiment be the justification for the assumptions made here.

4.1 OBJECTIVES

One of the personal objectives of this research is to continue with the research programme of J. J. Thomson, who by 1900 wished to "*rewrite physics in terms of the newly discovered electron, as well as to get beyond Maxwell*".

4.2 NEW METAPHYSICAL SCHEME

Section II was deliberately included to reflect the belief that all foundational theories must include an explicit discussion of their own entities, so that new readers can appreciate the foundations on which the rest of the theory rests. It is a foundational belief here that all quantum phenomena are grounded in the reality of the electron. Indeed, the overall thrust of the Universal Electron Theory (**UET**) is that **all** the basic particles discovered to date in high energy physics are no more than examples of composites of simply a few positive and negative electrons.

The **particle** hypothesis is first and foremost an **ontological** idea: it proposes that the physical existence of material reality occurs as a corpuscle – the smallest, indivisible 'atom' of matter. In contrast, the '**wave**' idea is associated with phenomena where very many components of material reality **interact** between themselves, usually restricted to a finite region of space during a span of time. Logically, ontology must precede the idea of interactions; something must exist before it may then interact. Therefore, as Newton suspected, the particle concept **must** be the foundation of material physics; in the present theory, these particle ideas are centered on each real **electron**. Since measurements need a form of interaction – between the target object (the smallest being one electron) and the vast system of electrons forming the macro equipment used by physicists then one should not be surprised that some observations record fluctuations in the interactions, even though these have often been misinterpreted as the existence of waves. The confusions and paradoxes surrounding QM arise from the rejection of the commonsense extension of 'naïve' realism to atomic systems and the positivistic view that only interactions with human beings (direct or indirect through their instruments) can **define** existence: the ultimate conflating of two very different philosophical concepts: ontology and epistemology. An analogy here with History may help; it would be very dangerous to believe that the reality of historical events is only defined by what professional historians tell us; all direct effects (such as descendants) would have to be ignored. Professional historians search for documentary evidence for their claims; a recent movie (*Denial*) illustrates the problems that arise when certain events (the Holocaust) are initiated with the deliberate avoidance of documentation to deny guilt.

This section introduced a three-part scheme deliberately separating the most powerful feature of humanity – our imagination, from all the bodily interactions which we participate in, including all our experiments on atomic scale phenomena. This moved the intrinsic fluctuations, arising from uncontrollable electrons from the universe, away from the ideal atomic systems we are explicitly measuring, into the series of experiments wherein the equipment setups must inherently vary: contrary to the assumption that humans can **exactly** repeat the experiments at the atomic scale. The central assumption here is that electrons are point particles that move inertially, as Newton predicted for all matter, but that interactions between electrons are more complicated than Maxwell predicted with his field theory of electromagnetism (EM): a set of differential equations transformed from the integral equations describing the cumulative effects of innumerable electrons, flowing through the macroscopic equipment of the Nineteenth century giants of EM research.

4.3 NEW MODEL OF QUANTUM MEASUREMENT

All quantum measurements involve **interactions** between macroscopic instruments (involving very many electrons) and a few target atoms. Even if the target system is reduced to a single electron then the smallest interaction is finite (Planck's quantum of **action**) and **never** becomes infinitesimal:- the implicit assumption hidden by the use of the calculus. Furthermore, the various techniques of introducing quantization all make the assumption that the calculated **averages** map directly to the averages computed from **repetitions** of measured quantities. Implicit in this whole process is the assumption that **identical** experiments can be repeated at the atomic level. Heisenberg (and many others) have admitted that measurements must 'disturb' the target system, so even the measured results reflect the combined system of target and measurement equipment; the result is that humans are **never** observing the world when we are **not** observing its micro behavior. This does not concern **Positivists**, who cannot believe in a world unobserved by humans.

4.3.1 A NEW INTERPRETATION OF QUANTUM MEASUREMENT

Rather than follow the understandable model of measurement proposed by Bohr and Heisenberg, later mathematical theorists preferred a mystical mathematical explanation, called the **Principle of Superposition**, which they have raised to a central QM hypothesis. In this approach, **all** the possible results **co-exist** at the same time and a single act of measurement simply picks out just one of these values. The subsequent analysis of the hydrogen atom will show that this is the result of trying to view a system, extended across space, all at the same unique time ("*God's View*"). This is an extension of the human ability on the small scale to observe proximate, multiple features "at once". In reality, the human eye is working as a massively parallel processing system, with many points in the retina interacting with different parts of the observed target within a time frame less than our brains can distinguish. The many results are then integrated into a seamless, single image by our active brain. This false notion of simultaneity has been objectified in mathematical models of reality since Newton, with the idea of a single parameter, designated as 't', that spans all of the target system. This is the implicit metaphysical assumption underlying both the Hamiltonian and Lagrangian formulations of mechanics. They are simple extensions of DesCartes' original idea of local, mechanical "touch" as the description of interactions.

The alternative view, explored in this programme, is that electrons interact remotely in an **asynchronous** manner, so that one single 'time' is never adequate (except as a limiting approximation) to the actual microscopic interactions. Furthermore, this new approach does not limit itself to the human experience of delayed interactions, which (in the case of animal memories requires construction of recording structures through time) but recognizes, at the microscopic level, that no one electron has a privileged position in time, so that symmetrical solutions, involving advanced and retarded interactions are equally possible. This new view has been incorporated in this programme [5] in the new model of what has been historically called '**spin**'. As most physicists will reluctantly admit: there is no rotational motion of the electron involved with this concept, as all finite models of the electron were proved inadequate over 100 years ago [2]. It must be noted that 'spin' has the dimensions of action and so is an intrinsic feature of electron inter**actions**. In fact, one of the key, early observations in this programme was the realization that action, angular momentum and 'spin' are all components of the concept of **activity**, when formulated as a Natural Vector [3].

4.3.2 FUTURE WORK

This section summarizes work in progress that will be published soon; these papers establish the broader context of the present work.

4.3.2.1 UET7C: Quantum Electron Mechanics (QEM1)

This paper is the complement of the recent Theory of Light [6]; it extends the new approach to a realistic theory of electrons; it builds on the present theory of quantum measurement. The results will reproduce the most detailed calculations of the energy-levels of the single electron hydrogen-like atoms, without using any form of continuum mathematics (i.e. calculus).

4.3.2.2 UET7D: Quantum Electron Fluctuations (QEM2)

This paper will provide a unitary (particulate) explanation for all the atomic-scale experiments (including the Twin-Slits) that have generated the weird idea that an electron exists as **both** an electron and as a wave.

4.3.2.3 UET8: Atomic and Molecular Electron Mechanics (MEM)

This paper applies the results of its three principal predecessors to the analysis of simple atoms and molecules. These techniques overcome the "**3-body**" barrier that has blocked analytic extensions of quantum mechanics to multi-electron atoms, such as helium etc. Energy levels are calculated algebraically for each of the atoms from hydrogen to neon. Simple, multi-atom molecules, such as hydrogen, oxygen etc. (which have resisted QM) are also analyzed with these new techniques.

4.3.2.4 UET9: Particle Electron Mechanics (PEM)

The Universal Electron Theory (UET) is extended to the realm of the sub-atomic particles. All-electron models of the three **neutrinos** and the various **mesons** are proposed. This analysis includes a new dynamic model of mass (without Higgs) so that algebraic calculations of particle masses can be developed *ab initio*. Additionally, a new model of the **electro-weak** force is provided that avoids all hypothetical quantum fields, such as the W or Z "particles". A new mechanism for electron-positron **pair creation** is also presented, which preserves the eternal existence of both positive and negative electrons.

4.3.2.5 UET10: Nuclear Electron Mechanics (NED)

This paper extends the discrete version of the EM interaction to the scale of the nuclear particles. New models of the proton and **neutron** are proposed that consist only of positive and negative electrons that avoid all use of field theory. The 'strong' force is shown to be a very short-range, saturated version of the new EM impulse developed earlier in the programme. A new interpretation of the so-called **quark** model is proposed. The dynamical model of particle masses (developed in PEM) is used to calculate the mass of the proton and the neutron, which agrees with observed values.

4.4 CONCLUSIONS

This research has proposed a new solution to the Quantum Mystery Problem: *what is the nature of atomic scaled systems?* By 1925, many brilliant mathematical physicists had constructed several mathematical schemes for calculating the energy levels of hydrogen-like atoms by alternating between two mathematical representations: the mathematics of particles (Hamiltonian mechanics) and the well-known mathematics of oscillatory systems (Wave mechanics). Unfortunately, these two schemes could not be 'reverse-engineered' (reified) back to reality: *Does the electron exist as a (localized) particle or as a (distributed) wave?* Physicists have reformulated this question: *What is the connection between Classical Mechanics and Quantum Mechanics?*

The approach followed here is to extend Dirac's reliance on "Classical Analogy" [§2.1.2.2], where this great theorist extended the successes of classical physics by assuming that matter existed at the atomic scale in the form of particles and then proposed hypotheses, which (implicitly) introduced de Broglie's revolutionary idea that electrons only interacted together on a periodic basis. Dirac, like many of his contemporary (and subsequent) physicists, had no deep interest in philosophy, so he believed that the usage of mathematics in physics was a direct mapping of reality, as he was Newton's successor at Cambridge as the Lucasian professor of mathematics. This belief worked well for Newton with his macroscopic view of planetary reality but there was no evidence that it extended successfully down to the atomic scale. The present theory resurrects the particle model at all scales by assuming that electron **trajectories** still make sense in the idealized model of isolated atoms and then linking this view to measurement mathematics of QM.

The **wave** idea has been over-promoted by mathematicians because of its inherent mathematical simplicity, reflecting the symmetries hiding implicitly within the definition of a circle. A vibrating string always **exists** as a 'string' (thing), even when the locations of its parts are varying over time (i.e. oscillating) to form the **pattern** of a wave, when viewed holistically. Mathematicians got it wrong: an object may act in a way readily describable by the mathematics of waves but this does not prove that the object exists as a wave. A subsequent paper will demonstrate that all the atomic phenomena that have been interpreted as waves are reflections of the direct consequence of the inherent **periodic** capacity of electrons to **interact** together. This perspective was sufficient to abolish the concept of "*light*" in a prior paper [6] and will prove capable of providing a purely particulate explanation of electron scattering. By conflating two of the basic components of atomic science (existence and knowledge), theoretical physicists have created the theory of quantum mechanics that is too complicated to untangle; this has persisted because its creation contained too many unstated assumptions and far too many metaphysical presuppositions (see UET7B).

The extensive use of the powerful technique of Fourier transforms should not smuggle in either the concept of waves or the addition of solutions (**Superposition**) to periodic particle models of atomic interactions. Furthermore, the mathematical technique of representing waves by complex exponential functions should also not be interpreted as always implying complex probability amplitudes in the wave function. (i.e. square roots of a probability abstraction). The present theory [§3.4.1] views each probability amplitude (i.e. A_n or B_n) as a separate, possible **real** event; one corresponding to a *Send* interaction from electrons in the measuring equipment and one corresponding to a *Receive* interaction in the equipment. As a corollary, one may view these events from the complementary perspective of the measured (or 'target') electron, where A_n is the *Receive* event and B_n is the target's *Send* event – all possibilities are present in a series of similar experiments. These elements are not mysterious manifestations of Special Relativity theory (as in Dirac's Relativistic Electron Theory of 'spin') but examples of the two distinct components of a **single** EM interaction, which occurs at two separated moments in space and time.

4.4.1 THE UNCERTAINTY PRINCIPLE

Many discussions of QM still obsess on the centrality of Heisenberg's Uncertainty Principle, as the limit at which human observations of the micro-world inevitably generate statistical results. This paper re-emphasizes that though this is a logical consequence of the operator mathematics of standard QM, there is a deeper level of reality at work here, which will always produce such statistical consequences when macroscopic attempts are made to exactly replicate "**the same**" experimental configurations. Indeed, this programme adopts a **many-body** view of the world where all attempts to isolate an atomic 'ideal experiment' are doomed to failure, as we have shown electrons retain a small finite interaction at extreme separations. These attempts to simplify our mental models of the world are viewed here as last-ditch attempts to save the **Continuum** model of reality and its associated continuum mathematics that have dominated mathematical physics for several hundred years, based on 2000 years of **metaphysical** preferences. These confusions have persisted because philosophers and scientists have had different ontological commitments, partly because they maintain different philosophies of language. Einstein and Heisenberg viewed light and matter as a single entity, expecting field theory to supply the fundamental ontology. Einstein pushed this perspective to where he called QM '*incomplete*' [33]; requiring the theory to reconcile field physics, deterministic causality and the physical continuum in 4 dimensions. These different perspectives result from deep metaphysical differences in world-views that might even be termed '**religious**' differences.

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