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Quantum reprogramming
A long Overdue and Least Intrusive Reality Adaptation of the Copenhagen Interpretation

EVERT JAN POST,
Breen Ave, Westchester, CA 90045-3357, USA
e-mail: evertpost@aol.com

ABSTRACT. This essay is an unapologetic proposal for incisive changes in the traditional Copenhagen interpretation of quantum mechanics. Instead of a single system, the Schroedinger Ψ describes an ensemble of identical systems obeying a classical statistics. Since the Schroedinger equation is now to be taken as solely describing randomized ensembles, it can no longer be regarded, and should no longer be used, as a method of primary quantization such as might be associated with single systems. The variational argument used by Schroedinger for obtaining his equation now graduates to a derivation from pre-1925 propositions of quantization. Following Kiehn [9], pre-1925 quantizations are recognized as part of a mathematical system of period (residue) integrals describing global topological structure of single systems. Since these single system tools operate in a pre-statistical realm, it follows Heisenberg uncertainty, which derives from Schroedinger's equation, now conveys limitations of observation associated with ensemble randomness. Following Planck, this randomness is maintained by the zero-point energy. For mathematical details of these conceptual alternatives the reader is referred to ref.5.

1 Contents

A Propos

In recent years Copenhagen has been at the center of attention through a play dealing with a wartime visit of Heisenberg to see Bohr, his mentor of earlier years. Both scientists had a measure of expertise that could have been instrumental in the at that time ongoing efforts of making nuclear explosive devices. The play portrays an encounter of two men between whom there had been a strong human bond of very important joint endeavors. Now, by nationality and birth, their lives were suddenly forced into vastly different directions due to what had to be deeply opposing positions.

The here-related Copenhagen story pertains to earlier work of these same two men and several others. Discoveries made by Heisenberg, Schroedinger and Dirac had led to an array of mathematical eigenvalue procedures holding a key to striking new developments in physics. The discipline ensuing from these detailed investigations is now known as quantum mechanics. It describes in minute detail spectral behavior of atoms and molecules. Much of this emerged within an interval of three years. For most people who later studied these events, the happenings would enhance a sense of awe for the mysteries of nature and the probing of the human mind.

Coinciding Events

Just prior to the just cited events, a now famous mathematical treatise by Courant-Hilbert had appeared, which seemed made to measure for all the mathematical needs of the quantum pioneers. The physics-based work by Heisenberg, Schroedinger and Dirac invited in fact an extending of the physical applicability of *Courant-Hilbert techniques* to the micro-domain. Since eigenvalues initially referred to resonances, say of macroscopic musical instruments, it now paved the way for resonances of micro-systems, say atoms and molecules. It was the beginning of an era of wave-monism, suggesting everything is *waves*, a sentiment still quite prevalent today.

At the time, it seemed as if God had given a battle-weary world a glimpse of insight into the wonders of nature after a four-year world war of mindless disruption and destruction. It sort of conveyed a growing awareness of rapprochement between science and religion. Instead of being perceived as mutually exclusive, there was now a feeling that science was becoming more religious and religion was becoming more science oriented. In this atmosphere of growing religious-scientific compatibility, young scientists started congregating in the city of Copenhagen under the inspiring guidance of Niels Bohr. They were aiming at an interpretive physical picture about what might be behind this string of amazing discoveries pertaining to the interrelated quantum tools created by Heisenberg, Schroedinger and Dirac.

Instrumental in the course of these considerations was an observation by Max Born holding the dependent variable Ψ of the Schroedinger equation to be of the nature of a probability-amplitude. In non-technical jargon, a probability-amplitude is like a square root of a probability density; the latter being a propensity of something per unit volume.

The Copenhagen Interpretation

At the time, late Twenties early Thirties, physics had been blessed with these mathematical gifts from heaven that could predict atomic behavior in minute detail, while at the same time manifesting a definite probabilistic nature. Faced with experimental information of that time, it stood to reason that a consensus emerged, perhaps prematurely drawn and beholden to opinions that all fundamental laws of nature might be inherently probabilistic.

Heisenberg's principle posed an a priori uncertainty of observation, conceived by thought experiment in 1927. It enhanced those earlier inherent probabilistic convictions. Some time later, Kennard showed Heisenberg's uncertainty to be a consequence of Schroedinger's equation. Quantum uncertainty so became instrumental in seemingly enhancing earlier existing opinions viewing Ψ as describing single systems.

By setting an *absolute* limit of knowing, the Copenhagen view of uncertainty abdicated explorations that were deemed outside the realm of man. Yet, this very act of delineating the prerogatives of man versus those of Nature seemed all by itself an intrusion of territory from which man was just trying to humbly withdraw. All of which shows the predicament of physics: physicists even appear arrogant when trying to be humble. The following sections show that the way out of this conundrum is a two-tier approach in which quantum uncertainty is a manifestation of a zero-point energy ascertaining a state of statistical disorder in an ensemble. Isolated single systems, which include ordered ensembles, are treated as pre-statistical.

Here, in a nutshell, we just summarized the conceptual entourage of the Copenhagen interpretation. Since it is taken to describe some sort of statistical behavior of a single system, the statistics, referred to here, would be inherent to the system itself. *Hence no obvious parameterization of states was forthcoming that could serve as a Universe of Discourse for such statistics.* Normal statistics include states of order with respect to which a state of disorder can be delineated by means of suitable variables.

Copenhagen at this junction had come to accept states of *a priori disorder* and *no state of order to compare with*. In response to the need of naming this unusually distinguishing feature, the Ψ function statistics was said to be nonclassical. This word became a fateful step in determining in what light much of quantum physics would be perceived in the next three quarters of a century. Questions how we recognize disorder, without a reference state of order, had not yet become part of a more incisive concern of that time. Having made this observation there is now an obligation to go a step further.

For the purposes of that time, this non-classical feature of the new quantum mechanics of the Twenties seemed at best a fitting temporary measure for processing a procedure bestowed on physics as a gift from heaven. Not looking gift horses in the mouth seemed a better part of valor, particularly so for gifts granted to man by Mother Nature. *In the light of this scenario may I conjecture, that that is how it came to pass that from that moment onward physics began dangerously lowering its guard for critical self-evaluation.*

In the course of time it became clear, the new formalism did far better in getting relevant answers than could be rationalized by its prevailing interpretive views. In fact this Copenhagen interpretation was haunted by paradoxes, ranging from assuming particles as point entities tunneling spontaneously through potential barriers. Once physics had gotten into the habit of receiving gifts from heaven, it became easier to accept companion miracles. One of them had to do with the nature of the so-called *zero-point energy:* $h\nu/2$.

Max Planck had saved physics from an embarrassing infinity, known as the ultraviolet catastrophe, with his now famous quantum hypothesis. Yet, when confronted with Schroedinger's zero-point energy, physicists felt obliged by Copenhagen dictum to again fill-up space with infinite energy.

Let us explain. Copenhageners equipped *every* harmonic oscillator with that zero-point energy, because they said the Schroedinger equation told them to do so. Planck, and before him Raleigh and Jeans had shown how any finite domain of free space accommodates an infinity of electromagnetic harmonic oscillators. Hence assigning each of them an ever-present zero-point energy $h\nu/2$ will surely create new energy infinities, just as Raleigh and Jeans had found out earlier with their thermal energy unit kT. Since Planck had saved the day for the Raleigh-Jeans infinity predicament, could we now trust him again to save us from Schroedinger's zero-point energy?

Max Planck's Conceivable Objections against Copenhagen Views

Ironically, Planck had earlier found that same (Schroedinger) zero-point energy residue $h\nu/2$ per harmonic oscillator in 1912, well before Schroedinger's equation was known. *He found this energy residue per ensemble element to be a minimal condition for (finite) ensembles to retain a state of optimal phase disorder [1].*

Copenhageners had bluntly assigned a state of obligatory phase disorder to the whole universe, by making *hν/2* a permanent attribute of every harmonic oscillator. They held this to be a new Copenhagen-Schroedinger doctrine. Yet, Planck had already saved physics also from this energy Armageddon. It seems the Copenhageners had never appreciated Planck's rescue, because still today they keep us immersed in this infinite zero-point energy.

Since Copenhageners justified their energy infinity with Schroedinger's equation, which had given so many relevant answers, one could hardly suspect something wrong in that equation. *So, perhaps the application of the Schroedinger equation to a single system had to be wrong.* Fortunately nature had generously supplied physics with phase random local ensembles for which Schroedinger's equation had given meaningful and fruitful results.

Yet notwithstanding the saving grace of Planck's early 1912 work also in this realm of physics, nearly a century later, physics is still perceived as living amidst those Copenhagen infinities. Worse, there is a whole discipline, known as quantum electrodynamics QED, in which a delicate balancing act involving infinities has been made into a fine art. It shows how people can learn to live with infinities. While physicists keep every small volume of space filled with infinite energy, astronomers complain about too little mass in the universe to keep things together. Are the QED people and astronomers on speaking terms? Have they heard of $E = Mc^2$? If E is infinite wouldn't M be too? Yet infinite mass might cause a Copenhagen universe to implode on itself; which would be the end of us all. The Copenhageners had an apocalyptic streak! Some of us more naive folks are holding out for a finite world leaving here and there some room for creating order.

Noting that nature still displays remnants of order, those apocalyptic Copenhageners would have to be wrong. So how did they manage involving us all in this process of getting science and religion closer? It was the power of magic. Some older physicists did not quite buy all this magic, yet they were overruled as too old to grasp this new way of doing business immersed in an ever-present nonclassical sea of infinite energy. The one overruled was Max Planck himself, the father of the quantum of action.

Ironically, in 1912 Max Planck had already provided a classical counter example proving the fortuity of these non-classical propositions of the Twenties. Planck's Zero-point energy is exactly the same *hν/2* as the one that later automatically popped out of Schroedinger's equation. The difference is, Planck's calculation gives the how and why of zero-point energy, whereas the Schroedinger equation only gives the how not the why. The moral of this lesson seems to say: *Copenhagen preoccupation with how, at* *the expense of why, had led to an unlivable space filled with infinite, optimally disordered energy.*

Supplementary Evidence Siding with Planck

Complementing the evidence in Planck's near-forgotten book is a famous contemporary text, *the Feynman Lectures on Physics* [2]. It offers a perfectly classical statistical calculation of another presumed non-classical Schroedinger result. It is the average of the modulus of angular momentum $\sqrt{n(n+1)}\ h$ for an ensemble of orientation randomized quantum rotators. The authors present this calculation in volumes II and III, *without identifying it as a counter example to Copenhagen's non-classical propositions*. They present, perhaps tongue in cheek, a challenge to the physics establishment. Was Feynman still uncertain to be more explicit? I presume these authors, as so many others, were unaware of Planck's example of zero-point energy. Had they known, one would have thought Feynman had the kind of personality that would have led to a confrontation right there and then.

Instead, the indirect challenge of the *Feynman Lectures* still stands and this humble member of the physics clan feels obliged offering the here-discussed options at demystifying quantum mechanics. Let the comment be: *Copenhagen ows Max Planck and others belated apologies for inappropriate references pertaining to "old age" and understanding, because the young Copenhageners were wrong and Planck and Einstein were right.*

At this point we know, beyond doubt, that Copenhagen's single system association with Ψ was wrong. This error led to a chain of fortuitous non-classical propositions. Other surprising near misses and omissions in the process of rediscovering Planck's position now need to be reported to appreciate the suggested interpretation changes in their fullest context.

The principal statistical parameters identified here are *mutual phase* and *orientation* of ensemble elements. These parameters have lived in partial obscurity for a long time. Had they been better known, Copenhagen's non-classical mythology might not have seen the light of day. In fact, David Bohm's search for hidden variables is living testimony that Planck's 1912 work on zero-point energy remained unread, even during the later Copenhagen era. It means; *David Bohm's hidden variables were not hidden to Max Planck.*

The fateful transition from Copenhagen's single system to a real ensemble of systems already emerged in the Thirties. Popper made a suggestion to this effect in 1934 in a letter to Einstein. The grandmaster of relativity responded with criticism, yet a footnote on the first page of Einstein's response explicitly supports Popper's proposition by acknowledging an *aggregate* (*i.e.,* ensemble) connotation for the Ψ function.

Max Jammer's edifice on *the Philosophy of Quantum Mechanics* [3] testifies to the existence of a viable real ensemble minority emerging in the Thirties. Today, single system and ensemble both seem unofficially accepted. Copenhagen calls on the abstract Gibbs ensemble for a single system versus Popper calling on a real ensemble of identical single systems. Yet, while rejecting the single system option, *this minority supporting the real ensemble bought wholesale into Copenhagen's premise of a non-classical statistics.* So, standard Copenhagen and the ensemble people both silently adhered to a primary status of the Schroedinger-Dirac equations. In doing so they prejudicially denied a conceivable existence of separate pre-statistical single system laws. This decision was equivalent to abandoning hope of ever finding a derivation of the Schroedinger-Dirac equations. Here we see how admitting nonclassical artifacts burns the bridges leading back to reality,

The Alternate Techniques Testify to A Two-Tier Situation

We have now established, and dare I say beyond a shadow of a doubt, that *the Schroedinger equation is a tool applying to a real ensemble obeying real classical statistics.* Since Heisenberg uncertainty is a consequence of the Schroedinger equation obeying classical statistics with an order reference, it follows that *quantum uncertainty can no longer be an absolute and always present manifestation.* So, the next task is one of establishing quantum rules for that pre-uncertainty realm.

Except for a forgotten footnote by London in the Thirties, the Aharonov-Bohm integral [4] had not yet surfaced as a major primary quantum tool. It is currently viewed as Schroedinger derived, thus inheriting Copenhagen's nonclassical prejudices and limitations. So, from now on *the Aharonov-Bohm integral is a counter of entities known as flux quanta.* Counting identical quanta should be independent of metric and reference specifications. *In the language of mathematics, this Aharonov-Bohm law meets premises of the general theory of relativity and is also metric independent as a counting procedure should be. This removes an old conceptual barrier between quantum theory and relativity.*

It is now clear why covariant transcriptions of the Dirac equation failed in yielding meaningful results, because *ensemble-based tools are not well suited for isolating ensemble-independent features of physical law.*

In retrospect, it is Schroedinger's equation with its statistical base that is contingent on the pre-statistical Aharonov-Bohm integral, not the other way around. In fact, Schroedinger's variational recipe to obtain his wave equation now emerges as a generalized process of Planck's zero-point calculation. *This perception change makes Schroedinger's recipe a derivation.*

In witness of how Planck has been ignored, it should not be surprising if a book account [5] of here cited interpretation aspects has been around for nearly a decade, without anybody noticing. It is on the shelves of many University libraries as Volume 181 of *The Boston Studies in the Philosophy of Scienc*e. Readers looking for details are invited to consult that volume.

From the Twenties until the present, physics just went too far in accommodating nonclassical beliefs. Retracing the steps of this extended odyssey in the pursuit of facts, one cannot help noting how close some protagonists were to opening up more realistic windows on the nature of quantum physics. What had prevented leading personalities of that time from pinpointing the predicament? In the light of new experimentation's relation to global mathematics, a principal hurdle is that physics' thinking stopped making the global transition, whereas mathematics did so roughly speaking during the era that physics began struggling with the quantum concept. De Rham's theory of the cohomology of fields [8] testifies to that. The reader can compare monograph [5] for its physics ramifications.

Some Perspectives on Recent History

It is known that Schrödinger was aware that his residual $h\nu/2$ zero-point energy reproduced Planck's earlier result and testified to that at some occasion. It seems he meant to investigate this coincidence of results. For reasons not known, he never got around to doing just that. The single system versus ensemble issue was at stake there and then.

Slater may have had an earlier controversy about this point with Bohr, which led to a fall-out between the two. Bohr's mind must have been set on a single system view and, as far as we know, so was Schrödinger, yet a presumed awareness of Planck's 1912 work may have made him less than dogmatic about that point. A meeting between Bohr and Schrödinger supposedly led to a dramatic confrontation of the minds. Schrödinger has been cited as regretting his involvement in the saga of quantization; strong language for the man who brought us his exquisite *favor of fortune*.

Bohr's mystical pursuit, which brought physics precious new insights and Schroedinger's refined mathematical approach to physics failed to harmonize. Schrödinger's process became in part crippled by the Heisenberg-Bohr relentless drive aiming at one all-encompassing statistical description. This statistical monism failed because not only did its nonclassical connotations corrupt the very nature of statistics, also experimental results were starting to point more and more at pre-statistical situations. The Copenhagen claim that the pre-1925 quantization conditions were to be considered as mathematical approximations should by now be considered as totally untenable. *The asymptotic relation between Schroedinger- and pre-1925 quantization refers instead to distinct physical situations: i.e., randomized ensembles versus single, isolated, elements; this provides the very basis for a two-tier quantum pursuit* [5,6].

This overdue revision of the Copenhagen interpretation does not detract from applications of the past, except in some highly ordered physical situations. The macro quantum manifestations of quantum interferometry gave rise to *a movement in quantum interpretation to consider the Ψ function as conceivably more fundamental than the Schroedinger equation that had produced it.* In other words, it was felt something might supersede the wave equation. An inspection of these situations suggests a need for making conceptual transitions from local to global domain. Quantum interferometer discussions tend to focus on the phase of Ψ, which is de facto an application of the Aharonov-Bohm integral. This integral can assume a state, which in mathematics has become known as residue or period state. As earlier mentioned, it physically means the Aharonov-Bohm integral becomes a counter of flux quanta. So, this integral interestingly reversed its roles from being offspring to holding parentage to Schroedinger's *favor of fortune*.

Let the flux quantization experiments by Deaver-Fairbanks and Doll-Naebauer[7] be seen as direct confirmations of this pre-statistic Aharonov-Bohm law. This counter of flux quanta is now a full-fledged relative of Gauss' law as a counter of charge quanta. To our knowledge, there have thankfully not been any attempts at deriving these fundamental quantum laws from the Schroedinger equation. A detail has to be added about the residues of the AB integral: in applied fields they are h/e in self-fields h/2e.

Explanations of the Josephson ac effect, normally argued from an extrapolated Ψ function angle, can equivalently be assessed in terms of the Aharonov-Bohm law. The quantum Hall effect, however, did not lend itself well for an assessment in terms of an extrapolated Ψ function. So people tried a Schroedinger equation approach, which led to an unfortunate dichotomy between integer and fractional effect. The dichotomy is easily resolved by a two quantum number approach invoking flux- and charge counters both for cyclotron states (BSPS 181). The highly ordered quantum Hall effect is pre-statistical and does not gibe with a Schroedinger approach.

All this poses a major question that may seem independent of physics. Why do people insist on complex over simple? The contemporary situation for survival in scientific research requires intense exploration of the available markets of grants, subsidies and contract prospects. Proposal writing of how to charm institutions and agencies known as supporting research has now developed into an art and discipline, which all by itself is being taught at academic levels.

This type of auxiliary specialization of how to serve other more principal specializations carries inherent dangers of viewing specialization as a goal all by itself. The chances of getting lost between all those specializations reminds us of a well known saying that says, the trees are preventing us from seeing the forest.

While we may flatter ourselves of knowing when and where to climb a high tree to find out where the forest goes, the truth of the matter is that confusion can sneak up on us before we know what is going on. Climbing a high tree so as to get an over-view of things only a first step in regaining our bearings in the quest for a more global view also in physics.

This word global has recently become a media fashion word in the context of the social ramifications of a world-wide economy. Mathematics and physics, generally regarded as close relatives, went through strange gyrations going back and forth between global and local. Mathematics went through a very definitive local to global transition about a century ago, whereas physics first made some hesitant global steps but then returned to local-based procedures.

The objective of this essay is an attempt at getting an overview of how these distinctive procedures have been active in physics in its relation to mathematics. It is like planning a strategy for an overall objective and then in the process being confronted with the tactical needs of how to get there.

Some History about Local and Global

Archimedes law about the buoyancy of a vessel being equal to the weight of the displaced water may well be regarded as the prototype of a global law going back two millennia. Newton's law of gravity likewise sort of started out as a global pronouncement, yet to make it precise he had to show how infinitesimal volume elements of mass would add up to the precise global statement of what we now know as Newtonian gravity.

If gravity laid the groundwork for the integral calculus, the subsequent formulation of Newton's laws of motion had to call on the concepts of what we now know as differential calculus. Attempts at formulating the first laws of physics stimulated the creation of a very important mathematical discipline. At this point it may not come as a total surprise that also Archimedes in the process of understanding his law of displacement had already been using early concepts of calculus.

Throughout the 18th and a major part of the 19th century the mathematics of physics developed and bloomed as an art of formulating and solving differential equations. The fundamentals of continuum mechanics were constructed from particle dynamics with the primary law statements retaining mostly the local form of differential equations. These developments produced a wealth of mathematical knowledge. The major way of obtaining global knowledge at that time was by solving differential equations. Theoretical Physics had become the art of solving differential equations.

Yet, in the course of the 19th century two new branches of physics were added to the existing branches of mechanics. They became known as Thermodynamics and discoveries pertaining to electricity and magnetism culminating in Maxwell's famous differential equations of electrodynamics. Both disciplines would reveal new relationships between local and global.

Thermodynamics started out with a differential formulation that is known as a Pfaffian equation. It was the integrability condition of that Pfaff equation that would reveal interesting global characteristics of thermodynamic behavior. Note hereby the difference between the concepts of integrability and an actual integration. These integrability conditions would become a crucial measure for global behavior of all entities involved.

Interesting about Maxwell theory is that it really started out as semi-global law statements that said things about global conservation. They are Faraday's conservation of magnetic- plus electro-flux: a cyclic two-dimensional space-time integral. The other is a 3-dimensional cyclic integral stating conservation of electric charge.

Those familiar with Maxwell theory know how these integrals laws can be reduced to differential equations with the help of the so-called Stokes and Gauss integral laws. These Maxwell differential equations have been the indispensable standby of electrical engineers and physicists for almost a century and a half. Via the constitutive definitions of electro-magnetic media these Maxwell equations led again to already familiar wave equations, hence all the previously acquired mathematical experience was now beginning to pay off in electrodynamics.

The reader should note here that the local Maxwell laws really derive from the global conservation laws of Faraday (flux) and Kirchhof (charge). People felt more at home with the differential version so that at that time little thought was given to the original global integral law statements.

A De Rham Superstructure of Maxwell Theory

Yet in the thirties of the 20th century the Swiss mathematician George de Rham would change that global neglect. He showed how integral statements of the fields could reveal topological structure of field configurations or alternatively the topology of the space in which the fields exist. In fact, formulating the integral laws one indeed had to call on the topological notions of *Enclosing* and *Linking*. So rather than converting the integral statements of Faraday and Kirchhof into differential equations, de Rham instead suggested to explore them and probe their implications for the ensuing field structure.

Although the technique was clearly inspired by Maxwellian theory, de Rham formulated his procedure to assess field topology for manifolds of arbitrary dimension n in which those fields might exist. Rather than speaking of field topology, in mathematical circles one preferred to speak of using fields in general to assess manifold topology. This de Rham technique required an extension of the Stokes and Gauss laws to arbitrary dimensions; results that were available from earlier work by Poincaré and Brouwer. This general technique for assessing topological structure using cyclic integrals is now called de Rham Cohomology [8].

While understandably an ab initio exposition of this discipline would be out of place in the present context, let it be mentioned that global consideration requires a distinction between exact fields and closed fields, before things had been more indeterminate, exact and closed were sort of identified. Locally a closed field may look locally like an exact field, yet the differences show only globally. Cyclic integrals are the chosen tools to verify the distinction. All cyclic integrals of exact fields vanish whereas only some cyclic integrals of closed field vanish others don't, that is where the topology structure comes in.

A theorem by de Rham says that except for an exact additive part, a closed field is defined by a basis set of its nonvanishing cyclic integrals. The values of this basis set of cyclic integrals are called the periods or residues of the fields considered. *While this may all sound abstruse, the truth is that similar matters are at least partially taught in undergraduate courses pertaining to electricity and magnetism: e.g.,* Gauss' theorem of electrostatics. So, the cyclic 2-dimensional Gauss integral is historically a first example of a period- or residue integral. *The fundamental quanta of plus and minus elementary charges are, if you will, the elementary basis residues or periods of the Gauss integral.*

The mathematical procedures utilized in those undergraduate courses are not quite adequate to convey all the perspectives of a full-fledged de Rham approach. The latter shows how the Gauss integral is a metric- independent topologically invariant structure, the residues of which are not only scalars, they are over and above constants.

Interlude on Pseudo- and Absolute Scalars and Metric independence

At this point some remarks about orientation changes are in order to delineate the situation between crystal physics, standard physics and de Rham theory. Crystal physics identifies *electric charge as a pseudo scalar,* in keeping with the phenomenon of enantiomorphic pairing in crystals. It also means charge polarity is a manifestation of enantiomorphism. This extrapolation from crystal macro-domain to particle micro-doman is compatible with the fact that orientation changes are metric-independent operations. Standard physics' use of vector analysis, which does not permit orientation changes, places the effect of orientation changes in the realm of ad hoc operations. Extrapolation from crystals to micro objects was a no-no!

By contrast, de Rham's book Variétés Differentiables [8] starts out with the option of having what he calls the pair-impair distinction. Unfortunately, the book does not pursue a systematic follow-up with that distinction in later chapters. Since the book appears influenced by physical perspectives, the absence of a systematic follow-up in standard physics may also have caused a lack of further concern in mathematical circles. The fact is parity and time reversal in particle physics are ad hoc and cannot serve as an inspiration to mathematicians for taking on mathematical needs of physics.

To make up for the here-cited omissions of the past a systematic use of orientation changes in physics will require the pair-impair distinctions as made in the introductory chapters of de Rham's book. Note hereby how pseudo scalar properties are associated with a nontrivial mirror pairing in macro-domain, *e.g.,* left and right handed quartz crystals as well as micro-domain pairing *e.g.,* electron- positron pairing.

More de Rham Superstructure of Maxwell theory

Now that we have established the residue status of the 2-dimensional Gauss integral and its relation to orientation changes, the question arises: now that we have a residue integral that gives us charge quanta $\pm e$, how about other physics-based residue integrals?

The 2-dimensional Gauss residue integral is two centuries old. There is a 1-dimensional residue integral of the vector potential for flux quanta. The quanta generated by superconducting rings were experimentally found to be multiples of $h/2e$. The flux residue is an ordinary scalar, hence there is no polarity pairing here. Since e was found to be a pseudo scalar it follows that h is also a pseudo scalar.

The here cited flux quantization requires the integration loop to reside in a field-free domain *i.e.,* E=B=0; it is the standard requirement for this residue integral, the condition can be met in the superconducting realm.

Electron interference experiments linking a magnetic flux have revealed a flux periodicity that goes in steps of quanta *h/e*. [2, appendix vol.III]. The same flux periodicity is exhibited by the flux linked by different electron orbits circulating in a magnetic field. The latter conclusion obtains from cyclotron energy states. It raises a question however; can the last result still be governed by a period integral description?

The problem is that the period condition for the integration loop to reside where B=0 is not met for the cyclotron orbit. This problem can only be solved, if the electron itself can be taken as having a field-free interior. *The latter option is indeed sine qua non for model-based attempts at assessing electron properties.*

The residue dichotomy of two flux units h/e and h/2e relates to whether or not observations are made in external magnetic fields (h/e) or internally generated fields (h/2e), see [5].

Now that we have period integrals for electric charge *e* and flux *h/e*, one may think of the Bohr-Sommerfeld integral as the period integral for action $\oint pdq = nh$. The problem though is that p is not really a field but a trajectory related quantity.

Following Kiehn [9] we take here a little detour using the language of forms. Since flux and charge are field related, one may think here of an electromagnetic field equivalent of angular momentum given by the exterior product $A \wedge \tilde{G}$ in which *A* is the pair one-form of flux and $\tilde{G}$ is the impair two-form of charge; the tilde marks it as an impair form yielding the enantiomorphic nature of charge. When it can be decomposed, its 3-dimensional period integral yields the product of two now familiar period integrals.

$$\oiiint A \wedge \tilde{G} = \oint A \oiint \tilde{G} = n\frac{h}{e}se = nsh;\ \text{n=1,2,...s=1,2, or 2,4,...}$$

For *s=1* this integral reduces to the Bohr-Sommerfeld condition. For superconducting rings *h/e* becomes *h/2e* but *s* stays even.

Step by step a complete set of period integrals has now emerged, they serve as global quantizers of micro-structures as well as *ordered* meso- or even macro-structures. With three period integrals, quantization manifests itself more and more as a necessary attribute ensuing from the discreteness of the micro-structure of matter. Unlike the Copenhagen view of Schroedinger's procedure, now a modeling of micro-matter is essential, because without it we cannot know how the integration cycles intertwine. In other words, probing the micro-world with this set of period integrals is the equivalent of a hands-on exercise in applied micro-topology.

Previously, with Heisenberg uncertainty ruling supreme, we could permit ourselves to relax our concerns about the micro-domain, because the Copenhageners had taken such preoccupation as an ambition outside the realm of human knowing. These experiences seem to reveal that man has difficulty determining where and what the limitations of his knowing are. Driven by caution, the Copenhagen interpretation with its nonclassical shortcuts was merely trying to be more restrictive than Mother Nature herself.

How does all this affect the Schroedinger Process ?

From the beginning, Copenhagen viewed the Schroedinger equation as some sort of mystery tool that held the key to almost all, if not all atomic and molecular questions. In accordance with that point of view a premature, yet firm conviction developed holding the Schroedinger Ψ function as a key to the secrets of single atomic or molecular structures. There was at the time no compelling reason for that conclusion. It was rather that one felt Schroedinger's favor of fortune ought to be given the benefit of the doubt.

The critical items of information provided by Schroedinger's equation were in the first place its eigen-values for stationary states, the Ψ itself held a secondary place. Yet integrals of the latter were found to have a role in obtaining a quantitative insight in transition possibilities between states. The sequence of eigen-function constitute an orthogonal set that spans *a configuration space*. All these things remain intact. Hence by and large Ψ remains a calculation intermediary that serves to get to the eigen-values, similarly as the eigen vectors in the matrix version of the theory. Yet, the global structure of the Ψ space became a rewarding topic of investigation, because with the help of group representation theory it revealed at least some information about the corresponding space-time structure of the ensemble elements and vice versa.

Also these mathematical features remain valid, yet compared to the past there is only one restriction. Schroedinger's equation applies to real randomized ensembles. An historical exchange between Heisenberg and Schroedinger in Munich on the occasion of the latter's presentation of his then newly developed wave-mechanics may be seen as foreboding a two-tier position. At the end of the lecture, Heisenberg asked the speaker whether the new equation could account for the photo-electric effect. Schroedinger took his response under consideration, but later came with his conclusion: no!

From a general point of view, transitions are known to be either spontaneous or induced from outside. A single system view of the Schroedinger equation leaves the totality of implied transitions options unsupported by the ensemble. It stands to reason that the interaction of the randomized ensemble elements contributes to the transition mechanism. The reader is referred to the massive evidence supportive of the ensemble view in sections 4, 5 and 6. *The unreasoned and unfounded persistence of a single system view, throughout the literature, illustrates a danger unleashed by nonclassical methodology. It tells us not to acknowledge unmistakable contradiction.*

It all goes to show how much conceptual trouble can be avoided if the Schroedinger process remains restricted to experimental observations invoking ensembles that consist of randomized identical single systems.

Conclusion

Summarizing this tale of *quantum reprogramming,* let us conclude that there is no absolute state of an always present, all pervading quantum uncertainty. Its associated energy would fill every finite bit of space with an untenable infinite energy. Instead, quantum uncertainty marks an ensemble state of residual disorder, say coexisting with the thermal realm. Zero-point energy governs transitions from ensemble order to disorder.

The Schroedinger-Dirac tools of quantum mechanics solely deal with ensembles so disordered, this provision constitutes a restriction compared to standard Copenhagen views, which also admits single systems as treatable by the Schroedinger process.

Single systems and *ordered* ensembles thereof are described by so-called residue states of, in part, already familiar cyclic integrals: Aharonov-Bohm for flux quanta, Gauss-Ampère for charge quanta, and the Kiehn product integral for action quanta.

Compared to the Copenhagen original, this revised interpretation, avoids infinities, obviates nonclassical propositions, identifies Schroedinger-Dirac for ensemble use, with single system quantum tools specifying quantum topology. *What could be preventing physics from adopting this alternative?*

Existing borderline applications of the Schroedinger process are living testimony of an ongoing practice of silently sneaking in pre-statistic situations to be processed with statistical tools. In the long run these automatic choices (*e.g.*, see next ref. 10) need to be brought in the open, lest they become a source of more ongoing concern. More aggressive identification of poorly defined and semi-accepted nonclassical situations is hereto necessary as well as an overview of tools for dealing with pre-statistical situations.

An explicit proposition to entertain a general period integral description of primary quantization [9] has been around since 1977. A proposition to consider using period integration for a two quantum number description of the quantum Hall effect [10] appeared in 1982. Shortly thereafter, the first publications reporting a fractional quantum Hall effect came out. A Schroedinger-based process is currently its officially adopted description.

The ratio of two quantum numbers seemed a more natural way of accounting for this fractional effect by placing the period (residue) integrals in the focus of attention for highly ordered manifestations such as the quantum Hall effect.

Instead, Schroedinger approaches to the fractional quantum Hall effect have generated an extravaganza of nonclassical propositions ranging from fractional charge to exotic new fermions underlining a presumed different nature of integer and fractional effect. Over two decades there has been an explosion of papers pertaining to the fundamental differences of these effects. Excepting the present author, not a single paper can be found making comparisons with a period integral alternative.

Recently, however, Mead [11] gave a two quantum number account of the two effects, he neither refers to the prevailing Schroedinger-based dichotomy nor to the earlier period integral alternative. Predictably, the Schroedinger-based clan is not going to refer to Mead's alternative.

The here-cited publication anomalies are hardly a compliment for a medium priding itself for its carefully screened review policies. There is understandably a reluctance to explicitly break with Copenhagen doctrine. However, to *feel* that reluctance there has to be more mature awareness of how Copenhagen doctrine is involved. An inspection of the literature reveals a tendency to avoid issues outside existing narrow realms of specialization.

Here we touch on a general state of conscience of participants. The functioning of conscience is contingent on a person's realm of relevant experience. The narrower the experience, the greater is the tendency of accepting miracles and getting on bandwagons to feel safe.

The bigger question is now: what can be done about mental stratification induced by overspecialization? Contemporary editors and reviewers have all been educated in an era that learned to live with those *nonclassical* blind spots. Yet, they feel duty bound to religiously defend and preserve what they believe to be the original or currently accepted versions of Copenhagen views. Reduced rational processing in physical theory has made this discipline more susceptible to seeking recourse in dogma when rational progress is not forthcoming.

All science may initially start out with a religious sentiment of inspiration to be substantiated or rejected. Contemporary physics has carried this religious phase of inspiration beyond the point where a process of rationalization can still catch up with the need of giving it a reality test. This uncertain state of reasoning in physical theorizing has remained unknown to the world at large, shielded as it is under an obtuse cover of abstruse higher mathematics. In a recent book, Mara Beller [12] has approached this very topic from an angle of philosophy and psychology. It should be indispensable reading for those who want a perspective on how to get out of a *cul de sac* of nonclassical self-deception.

Contemporary complaints of physics being overloaded with mathematics hold some truth. More involvement with *mathematical form* can avoid much *unsuitable mathematics.* Using Schroedinger's statistics-based equation on pre-statistical situations (*e.g.,* quantum Hall effect) is a case in point; a *form* choice of pre-statistic period integrals clears much obscure math.

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