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On the Foundation of Hadronic Mechanics: Iso-Mechanics and Geno-Mechanics

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Abstract

Hadronic mechanics was developed to be an extension of quantum mechanics. In this current study, the motivation for this extension, the formulation of hadronic mechanics from the general dynamic equation for the actual analytical description of nature as envisaged in both Lagrange and Hamilton original works and the need for new mathematical covering of this formulation are examined. The purpose is to provide useful background study to those interested in hadronic mechanics especially those interested in our theory of superconductivity whichis based on hadronic mechanics and has been used to progressively account for unconventional superconductivity hence has a sufficient natural foundation for a generalized theory of superconductivity.

Keywords: Quantum mechanics, Hadronic mechanics, Hadronic mathematics, unitarity, algebraic structure

1.0 Introduction

In a number of studies, we have adduced an exoteric formation of the Cooper pair and its coherent propagation to account for superconductivity beyond the validity of quantum mechanics: in particular, we consider iso-superconductivity model [1-5] and geno-superconductivity model [6]. The former was actuated by the need to generalize the standard BCS model by the inclusion of non-local, non-Hamiltonian formulation as a more natural mechanism for the Cooper pair formation (CPF) and its coherent propagation which is key to a successful theory of superconductivity [1-4]. The iso-superconductivity model has been progressively used in accounting for the high temperature cuprate and iron based superconductivityas well as prediction of room temperature superconductivity (see Ref. [3] for this progress). Thegeno-superconductivity theory which is a progressive generalization of the iso-superconductivity theory is founded, in algebraic and geometric terms, on extensions of the underlying Lie-algebraic structure of the BCS model to include ellipsoidal and toroidal deformations of a spherical Fermi surface that is essential for superconducting materials with quasi-crystalline structures [6]. The foundation of both the iso-superconductivity model and geno-superconductivity model is the inclusion of the contact interaction of the constituent particles of the parent superconducting materials which is beyond the foundation of quantum mechanics action-at-a-distance interaction of the constituents. The former foundation which has evolved today as hadronic mechanics became necessary as a covering to advance quantum mechanics. Now the hadronic mechanics with all its successes as an emerging theory beyond quantum mechanics has not yet attracted the same broad followership like quantum mechanics because of the overwhelming success of the latter even though it has a number of limitations [7-10]. Another reason for the not too popularity of the hadronic mechanics is the new mathematical numbers and fields developed as necessity for it to be consistent with experimental results [10, 11]. The purpose of this present work is to account for how the foundation of the hadronic mechanics necessitated the new mathematics and fields. In particular, the iso-number and iso-field which are the foundation of iso-mathematical tool for iso-mechanics and geno-number and geno-field which are the foundation of geno-mathematical tool for geno-mechanics that have been adopted in our aforementioned theory of superconductivity will be discussed, hoping this will provide useful background study to those interested in hadronic mechanics especially those interested in our theory of superconductivity.

The plan of this paper is as follows. In the section 2, the foundation of the hadronic mechanics will be examined culminating in the need for new mathematics which will then be examined in section 3. This will be followed by a brief summary and conclusion.

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2.0 The Need to Move Beyond Quantum Mechanics

The motivation for Santillito develop a covering to advance quantum mechanics emerged from his studying the original papers of both Lagrange and Hamilton on the actual description of nature [7]. He observed that the analytical description today are indeed truncated forms of the actual description of nature in these original works.
In the case of the Lagrange original analytical representation of nature, L_o, it has three main quantities which in a simplified form here is:

$$L_o(t,r,v) = K(v) - V(r) + F(t,r,v) \tag{1}$$

where r = x, y, z are the spatial coordinates, $v = dr/dt$ is the velocity, $K(v) = mv^2/2$ is the kinetic energy, *V(r)* represents all action-at-distance forces derivable from a potential while *F(t,r,v)* are the external terms to his equation and they represents all forces not derivable from a potential.
The Hamilton ‘s original analytical description, H_o, has a form similar to that of Lagrange as can be seen in the simplified form here as

$$H_o(t,r,p,...) = K(p) + V(r) + F(t,r,p,...) \tag{2}$$

where velocity is now replaced with momentum, $p = mv$and the other parameters retain their earlier meanings.
Santilli pointed out that both Eqs.(1) and (2) remained as tools for the analytical description of nature until the 1900 when the births of the special theory of relativity and quantum mechanics led to the neglect of the external terms so that both equations are reduced respectively to

$$L_T(r,v) = K(v) - V(r) \tag{3}$$

and

$$H_T(r,p) = K(p) + V(r)\,. \tag{4}$$

Eqs.(3) and (4) are known today respectively as the truncated Lagrange (L_T) and truncated Hamiltonian (H_T) while their external parts are known respectively as the non-Lagrangian and the non-Hamiltonian.
The general argument for the truncation was that when a system is reduced to its elementary particles, that is the microscopic level which is in the purview of the special theory of relativity and quantum mechanics, the external terms becomes negligible so that nature assumes only the truncated forms. However, Santilli and co-workers have been opposing this line of thought on the ground that there is no physical reason why the external forces will not play a role in the analytical description of nature at the microscopic level especially as they do affect macroscopic systems. This is summarized in the theorem [7, 11]:
A macroscopic system under contact nonpotential interactions cannot be consistently reduced to a finite number of particles under interactions solely derivable from a potential. Vice versa, a finite collection of particles all under sole potential interactions cannot consistently yield a macroscopic system with contact nonpotential interactions.
A common example to illustrate the theorem is the contact interactions experienced by a spaceship during re-entry in our atmosphere which is a collection of contact non-potential interactions experienced by the particle constituents of the space-ship and our atmosphere. Another example is the formation of the Cooper pairs from the interaction of electrons. Quantum mechanics considers these electrons as point-like charges so that they interact at a distance, via the Coulomb potential: then Eq.(4) can be re-expressedin relative coordinates and reduced mass m for two electrons in singlet coupling as [12]

$$H_T(r,p) = \frac{p^2}{m} + \frac{e^2}{r}\,. \tag{5}$$

It is easy to see that Eq.(5) cannot account for the binding of the electron via the physically repulsive Coulomb potential to yield the Cooper pair formation. To get around these problems, workers from the hadronic mechanics school of thought believe that the electrons have extended wavepacketsof the order of 1 fm, making them to have deep mutual penetration which implies contact type interaction over the volume of mutual overlapping that is non-trivial, nonlinear, nonlocal-integral and non derivable from a potential or a Hamiltonianthat is capable of producing an attraction of the electrons to bind into the Cooper pairs while preserving the physical variables [1-6,12].The implication is that Eq.(2) becomes the natural equation in describing the formation of the Cooper pairs in superconductivity.
From the above two examples here and many others that can been found in the vast literature of Santilli and co-workers, we need to include thecontact non-potential interactionsor perhaps some even more enhanced form of the external terms to go beyond the approximated foundation of quantum mechanics in order to achieve actual description of nature at the microscopic level. This can be likened to the common approach in physics of initiating studies of system using small densities before dealing with the complexity and rigour of the actual density. While consideration of the small densities provides us with useful insight, the near actual density cases often provides us with results closest to the experimental situations. Thus if we must get closest to the experimental situation at the microscopic level, then we must go beyond the foundation of quantum mechanics by including the external terms.

The difficulty now is how to go beyond quantum mechanics without destroying its very great successes [13] which includes the ability of preserving over time the units of measurements, the observable character of physical quantities via their hermiticity andthe consistency of numerical predictions under the same conditions.Since quantum mechanics is the mathematical formation of the physics at the microscopic scale, its successes emanates from its mathematical structure. For example, its aforementioned ability of preserving the units of measurements over time emanates from its unitary structure, namely, that its basic time evolution constitutes a unitary transform on a Hilbert space, $H = H^+$:

$U = exp(Hti), UU^+ = U^+U = I.$ (6)

This is maintained in the time evolution of the physical quantity expressed as Hermitean operator Q(t), such as energy, angular momentum, etc:

Q(t) = U(t) Q(0) U(t)+ = exp(Hti) Q(0) exp(-itH) (7)

The time evolution is consistent in the truncated Hamiltonian equation

$$\frac{dA}{dt} = [Q, H] \tag{8}$$

where the brackets are the celebrated Poisson bracketsthat is key to the Lie algebra structure that governsthe foundation of quantum mechanics time evolution of the physical quantity Q(t), which is given by the Heisenberg's equation in their finite and infinitesimal form

$$i\frac{dQ}{dt} = QH - HQ = [Q, H], \tag{9}$$

where the Lie algebra has an axiomatic total antisymmetric character that make quantum mechanics a reversible theory:

$$[Q, H] = QH - HQ \equiv [Q, H]^+ . \tag{10}$$

Similarly, the time evolution of a physical quantity Q*(t)* with the external terms added is:

$$\frac{dQ}{dt} = \frac{dQ}{dr}\frac{dr}{dt} + \frac{dQ}{dp}\frac{dp}{dt} = [Q, H] + \frac{\partial Q}{\partial p}F = (Q, H) . \tag{11}$$

It is easy to observe in Eq. (11) that the external term has introduce an addition term to the Poisson-Lie bracket which resulted to the loss of all algebra (and not just the loss of the Lie algebra). Thus in extending the truncated analytical description of nature *[Q,H]* to the actual description *(Q,H)*, the unitary structure which is key to the success of quantum mechanics has been invalidated:

$$U(Q, H)U^+ = U\left([Q, H] + \frac{\partial Q}{\partial p}F\right)U^+ \tag{12a}$$

$$UU^+ = 1 + \frac{\partial Q}{\partial p}F \neq 1 \tag{12b}$$

Therefore, it becomes impracticable to apply the conventional mathematics and methods of quantum mechanics in dealing with Eq.(11) in line with the theorems of catastrophic inconsistencies of nonunitary theories which state [9-11]

All theories with a nonunitary time-evolution, $U(t)U^+(t) \neq I$, when formulated with mathematical methods of unitary theories (conventional fields, spaces, functional analysis, differential calculus, etc) do not preserve said mathematical methods over time, thus being afflicted by catastrophic mathematical inconsistencies, and do not preserve over time the basic units of measurements, Hermiticity-observability, numerical predictions and causality, thus suffering catastrophic physical inconsistencies

The physical implication is that Eq.(11) cannot be used for any reliable physical analysis and interpretation of nature as has been done with Eq.(9). Thus there was a dire need to develop a new suitable algebra for Eq.(11) to be a covering of the Lie algebra that restores the brackets of the time evolution in Eq.(8). The approach adopted by Santilli was to reformulate Eq.(2) to depends on a second quality besides the Hamiltonian that restores this suitable algebra by generalizing the basic unit into a form explicitly dependent on local variables generally used in physics, $\hat{I}(t, r, p, E, ...)$. This leads to a new algebraic structure,

$$(Q, H) = QTH - HT^+Q . \tag{13}$$

In Eq.(13), if $T = T^+$, it is called Lie-isotopic and if $T \neq T^+$, it is called Lie-admissible with $T = \hat{I}^{-1}$ which preserves all the axioms of boundedness, smoothness, nowheredegeneracy, Hermiticity and positive-definiteness.

Taking into account Eq.(13), the fundamental dynamic equation for hadronic mechanics is obtained by re-expressing theHeisenberg equation in its finite and infinitesimal formas

$$i\frac{dQ}{dt} = QTH - HT^{+}Q = [Q, H]^{*}, \qquad (14)$$

which for the Lie isotopic dynamic equation is

$$i\frac{dQ}{dt} = QTH - HTQ = [Q, H]^{*} \qquad (15)$$

$$Q(t) = W(t)Q(O)W(t)^{+} = \exp(iHTt)Q(0)\exp(-iHTi) \qquad (16)$$

$$W = \exp(iHTt), \qquad WW^{+} \neq 1 \qquad (17)$$

And for the Lie admissible dynamic equation is

$$i\frac{dQ}{dt} = QTH - HT^{+}Q = [Q, H]^{*} \qquad (18)$$

$$Q(t) = W(t)Q(O)Z(t)^{+} = \exp(iHTt)Q(0)\exp(-iHT^{+}i) \qquad (19)$$

$$WZ^{+} \neq 1, \quad WW^{+} \neq 1, \quad ZZ^{+} \neq 1 \qquad (20)$$

Now having achieve the generalization of the algebraic structure for Eq.(11), there was an immediate need for a corresponding generalization of the conventional mathematics and methods in quantum mechanics for Eqs.(15) and (18) respectively.

3.0 The New Mathematics for the Hadronic Mechanics

Mathematics is the language with which the physicist communicate his ideas compactly, economically and beautifully [14]. Historically, in pre Newton era, algebra and geometry was already being used to build marvelous works of architecture, including the great pyramids of Egypt and later the great cathedrals in Europe. However, algebra and geometry can only describe stationary objects or phenomena. In order to describe dynamic objects or phenomena, Newton invented calculus. This trend has continued among theoretical physicists since then as they often either adopt mathematical methods that suites their formulation or even invent new ones. For example, Dirac had to introduce two valued quantities now known as spinors to get away from tensors which he believed were inadequate then to develop a relativistic quantum theory to develop his celebrated theory of relativistic electron [13-15]. Another example is that the formulation of matrix quantum mechanics by Heisenberg was instigated by his uncertainty principle. For it is now generally accepted that an important property of operators which represents the physical observables of quantum system is whether they commute, that is, $[A, B] = AB - BA = 0$.This is because a necessary and sufficient condition for the simultaneous measurability of two or more observables in any system is that their corresponding operators commute. Consequently, for any given system, there are only a limited number of possible simultaneous measurements that can be made because there always exist only a maximal set of commuting operators. This whole observation which is the aforementioned axiomatic antisymmetric character upon which quantum mechanics is developed, emanate from the Heisenberg uncertain principle which states that two complimentary quantities cannot be precisely measured simultaneously, that is, their operators do not commute: $[A,B] \neq 0$ [16]. Since we are often involved with complimentary quantities in quantum mechanics, the implication is that we are involved with algebras that are non – commutative. Since matrix multiplication is in general non-commutative, Heisenberg naturally adopted matrix algebra in his formulation of quantum mechanics even when it was not so popular then. In general, quantum mechanics development is based on this anti-commutative algebra.

The purport of the above discourse is to highlight an important methodology in physics wherein the workers have to adopt or even develop new mathematical tools to enable them communicate their new observations in physics that are consistent with nature [14]. This is the approach of Santilli in developing new numbers and fields for reversible and irreversible processes to advance hadronic mechanics as a covering for quantum mechanics. The new numbers and their corresponding new fields are: iso-numbers and iso-field, geno-numbers and geno-field and hyper-numbers and hyper-field. The first two which emanate from Eqs.(15) and (18) respectively were proposed to investigate hadronic mechanics and hence hadronic chemistry while the last one which is an extension of the geno-numbersis to investigate hadronic biology [17]. Thus the discussion here will now be focused on the first two especially as we have adopted them in our theory of superconductivity.

3.1 Conventional Numbers and Conventional Field

For the purpose **of**clarity, a brief review of the conventional number and conventional field is presented here. As the name connotes, the conventional number, n is our current standard numbering system which has a remarkable developmental history. Its basic axiom is that if n is a set of the conventional numerical field F such that $F(n, \times, I)$ be a numerical field over numbers n with associative and distributive multiplication $n \times m$, (left and right) multiplicative unit I, then $I \times n = n \times I = n$, addition $n + m = p \in F$, and additive unit 0, $0 + n = n + 0 = n$, for $n, m \in F$.

3.2 Iso-numbers and Iso-field

The Lie isotopic dynamic equationgiven by Eq.(15) was the first covering of quantum mechanics developed by Santilli. Therefore it was also the first that required a mathematical covering. Theformulation began with the introduction of the isounit $\hat{I}$ = 1/T > 0, which is an arbitrary positive-definite quantity generally outside the original conventional set F(n, ×, I), provided that the multiplication, which is known as iso-multiplication, is suitably redefined in the form $n \hat{\times} m = n \times T \times m$ under which $\hat{I}$ remains indeed the correct left and right unit, $\hat{I} \hat{\times} n = n \hat{\times} \hat{I} = n$ for all elements of the set. The new number $\hat{n} = n \hat{\times} \hat{I}$ is called iso-numbers, and the new sets $\hat{F}$ is called the iso-fields:

$$\hat{F}(\hat{n} \hat{\times} \hat{I}) : \hat{I} = 1/T > 1, \quad \hat{n} = n \hat{\times} \hat{I}$$
$$\hat{n} \hat{\times} \hat{m} = (n \hat{\times} \hat{I}) \times T \times (m \hat{\times} \hat{I}) = (n \times m) \times \hat{I} \tag{21}$$

For a quick illustration, see Table 1 for the iso-numbersandiso-multiplication of 2 and 3 using the isounit $\hat{I} = 1/T$ where T is called the isotopic element and it is the inverse of conventional number ranging from 2 to 9. Observe that unlike the conventional numbers in which 4 in the conventional field is not a prime number, the iso-number 4 is a prime number in the iso-field.

Table 1: A table showing theiso-numbersandiso-multiplication of 2 and 3 using the isounit $\hat{I} = 1/T$ where T is called the isotopic element and it the inverse of conventional number ranging from 2 to 9.

Isounit I	Isonumbers $\hat{n} = n \hat{\times} \hat{I}$	Isomultiplication $n \hat{\times} m = n \times T \times m$
2	4	12
3	6	18
4	8	24
5	10	30
6	12	36
7	14	42
8	16	48
9	18	54

Like the conventional mathematics, there has been extension of the isotopytoall mathematical structures used in physics such as iso-spaces, iso-transformations, iso-algebras,iso-groups,iso-symmetries,iso-representations andiso-geometry. Thus we now have a full fledge iso-mathematics to investigate iso-mechanics which is the isotopic branch ofhadronic mechanics. The iso-mechanics can be applied to systems that are isolated, reversible, and single-valued systems of extended particles under internal, local and nonlocal, linear and nonlinear, potential and nonpotential forces.

3.3 Geno-Numbers and Geno-Field

The restriction of the Lie isotopy theory to reversible systems was inherent in the development of the theory. This is because Eq.(13) with T = T^+ hence Eq.(15) still retain the total antisymmetric structure of Eq.(10) that make quantum mechanics a reversible theory. The implication is that the left unit and the right unit is the same so that even if the process moves forward in time or backward in time, the iso-numbers will be the same.

In nature, however, there are systems thatare irreversible so that the iso-mechanics can no longer be used to account for such systems. To surmount this problem, Santilli proposed a product that is not totally antisymmetric nor totally symmetric:

$$(Q,H) \neq \pm(Q,H)^+ \tag{22}$$

which is Eq.(13) with T ≠ T^+ hence the Lie admissible dynamic equationgiven by Eq.(18).

To develop the mathematics for this new theory, the formation started with a left unit that is not the same as the right unit to achieve a process which is irreversible, These two units now collectively known as genounit is denoted for the right by I^f *(*physically interpreted as forward in time and its geno-multiplication is $n \; x^f m$while the left unit is denoted by I^b *(*physically interpreted as backward in time and its geno-multiplication is $n \; x^b m$. These new numbers are called the geno-numbers and the new set is known as the geno-field wherein the forward geno-field is:

$$\hat{F}^f(n^f, \times^f, I^f) : I^f = 1/T > 1, \quad n^f = n \times I^f$$
$$n^f \times^f \times m^f = n^f \times T \times m^f = (n \times m) \times I^f \tag{23}$$

While the backward geno-field is:

$$^{b}\hat{F}(\ ^{b}n,\ ^{b}\times,\ ^{b}I):\qquad ^{b}I = 1/T^{+} > 0,\qquad ^{b}n =\ ^{b}I\times n$$
$$^{b}n\ ^{b}\times\ ^{b}m =\ ^{b}n\times T^{+}\times\ ^{b}m =\ ^{b}I\times\ (n\times m). \qquad (24)$$

As quick illustration, see Table 2 for the geno-numbers and the geno-multiplication of 2 and 3 using the genounits: $^{b}I = 1/T^{+}$ where $T^{+}$is called the Lie admissible backward element and it isa conventional number ranging from 2 to 9and $I^{f} = 1/T$ whereT is called the Lie admissible forward element and it the inverse of conventional number ranging from 2 to 9.

Table 2: A table showing geno-numbers and the geno-multiplication of 2 and 3 using the genounits: $^{b}I = 1/T^{+}$ where $T^{+}$is called the Lie admissible backward element and it isa conventional number ranging from 2 to 9and $I^{f} = 1/T$ where T is called the Lie admissible forward element and it the inverse of conventional number ranging from 2 to 9.

Backward Genounit ^{b}I	Backward Genonumbers $^{b}n = n\times\ ^{b}I$	Backward Genomultiplication $n\ ^{b}x\ m$	Forward Genounit I^{f}	Forward Genonumbers $n^{f} = n\times\ I^{f}$	Forward Genomultiplication $n\ x^{f}\ m$
2	1.00	3.00	2	4	12
3	0.67	2.00	3	6	18
4	0.50	1.50	4	8	24
5	0.40	1.20	5	10	30
6	0.33	1.00	6	12	36
7	0.29	0.86	7	14	42
8	0.25	0.75	8	16	48
9	0.22	0.67	9	18	54

Likethe conventional mathematics and iso-mathematics,there has been extension of the geno-numbers and geno-field togeno-spaces, geno-transformations,geno-algebras,geno-groups,geno-symmetries,geno-representations andgeno-geometry. Thus we now have a full fledge geno-mathematics to investigate geno-mechanics which is the Lie-admissibletheory ofhadronic mechanics. The geno-mechanics can be applied to systems that are open, irreversible, and single-valued systems of extended particles under external, local and nonlocal, linear and nonlinear, potential and nonpotential forces.

4.0 Summary and Conclusion

Quantum mechanics was developed from the truncated form of the actual analytical description of nature as enshrined in the original works of both Lagrange and Hamilton which had external forces that are non derivable from a potential. This limits the application of quantum mechanics to only systems having point-like constituents that are interacting via a potential. The inclusion of the external forces asnon-potential interaction due tocontact-type deep mutual penetration of the wavepackets of constituents at 1fm, leads to loss of the unitarity and Lie algebraic structure that are key to the time invariant and reversibility of quantum mechanics. Santilliapproach to resolving this problem was to develop a new suitable algebraic structure that restores the time invariant for the dynamic equation for actual analytical description of nature. This new structure, however cannot be studied with the mathematics and methods of quantum mechanics because their non-unitary structure will lead to catastrophic mathematical inconsistencies which will make them inapplicable in physics. Therefore, Santilli and co-workers have to develop new mathematics to restore the mathematical consistency that have culminated into iso-mathematics which is adopted for reversible physical process leading to iso-mechanics; geno-mathematics which is adopted for irreversible physical processes leading to geno-mechanics and hype-rmathematics which is adopted for time ordering physical processes leading to hyper-mechanics.These new mathematics are collectively known as hadronic mathematics which is a covering to the mathematics of quantum mechanics while the iso-mechanics, geno-mechanics and hyper-mechanics are collective known as hadronic mechanics which is a covering of quantum mechanics. It is pertinent to point out that hadronic mechanics has been expanded into hadronic chemistry [10,18] and hadronic biology [17]and there are already remarkable applications of all these branches both in understanding nature as well as in the industry [9,11,19].

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