From Yijing to Copenhagen Interpretation of Quantum Physics

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ABSTRACT

In the quest and search for a physical theory of everything from the macroscopic large body matter to the microscopic elementary particles, with strange and weird concepts springing from quantum physics discovery, irreconcilable positions and inconvenient facts complicated physics – from Newtonian physics to quantum science, the question is- how do we close the gap? Indeed, there is a scientific and mathematical fireworks when the issue of quantum uncertainties and entanglements cannot be explained with classical physics. The Copenhagen interpretation is an expression of few wise men on quantum physics that was largely formulated from 1925 to 1927 namely by Niels Bohr and Werner Heisenberg. From this point on, there is a divergence of quantum science into the realms of indeterminacy, complementarity and entanglement which are principles expounded in Yijing, an ancient Chinese knowledge constructed on symbols, with a vintage of at least 3 millennia, with broken and unbroken lines to form stacked 6-line structure called the hexagram. It is premised on probability development of the hexagram in a space-time continuum.

The discovery of the quantization of action meant that quantum physics could not convincingly explain the principles of classical physics. This paper will draw the great departure from classical physics into the realm of probabilistic realities. The probabilistic nature and reality interpretation had a significant influence on Bohr's line of thought. Apparently, Bohr realized that speaking of disturbance seemed to indicate that atomic objects were classical particles with definite inherent kinematic and dynamic properties (Hanson, 1959). Disturbances, energy excitation and entanglements are processual evolutionary phases in Yijing. This paper will explore the similarities in quantum physics and the methodological ways where Yijing is pivoted to interpret observable realities involving interactions which are uncontrollable and probabilistic and forms an inseparable unity due to the entanglement, superposition

Transgressing disciplinary boundaries in the discussion of Yijing, originally from the Western Zhou period (1000-750 BC), over a period of warring states and the early imperial period (500-200 BC) which was compiled, transcribed and transformed into a cosmological texts with philosophical commentaries known as the "Ten Wings" and closely associated with Confucius (551- 479 BC) with the Copenhagen Interpretation (1925-1927) by the few wise men including Niel Bohr and Werner Heisensberg would seem like a subversive undertaking. Subversive as the interpretations from Yijing is based on wisdom derived from thousands of years from ancient China to recently discovered quantum concepts. The subversive undertaking does seem to violate the sanctuaries of accepted ways in looking at Yijing principles, classical physics and quantum science because of the fortified boundaries that have been erected between Yijing and the sciences. Subversive as this paper may be, it is an attempt to re-cast an ancient framework where indeterminism, complementarity, non-linearity entanglement, superposition and probability interpretation is seen in today quantum's realities.

HISTORICAL PERSPECTIVE- COPENHAGEN INTERPRETATION

The Copenhagen interpretation is an expression of few wise men on quantum physics that was largely formulated from 1925 to 1927 namely by Niels Bohr and Werner Heisenberg. During 1926–27, Heisenberg served as Bohr's assistant in Copenhagen, where he formulated the fundamental uncertainty principle arising from quantum mechanics. Bohr, Heisenberg, and a few others then went on to develop what came to be known as the Copenhagen interpretation of quantum mechanics, which still provides a conceptual basis for the theory. Copenhagen Interpretation is not a totally agreeable framework that is generally accepted by the scientific community and it has contradictions and

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even myths in the conceptual framework in general (Camilleri, 2009). A central element of the Copenhagen interpretation is Bohr's complementarity principle which was presented for the first time in 1927 at a conference in Como, Italy. According to complementarity, on the atomic level a physical phenomenon expresses itself differently depending on the experimental setup used to observe it. Thus, light appears sometimes as waves and sometimes as particles. For a complete explanation, both aspects, which according to classical physics are contradictory, need to be taken into account. The other towering figure of physics in the 20th century, Albert Einstein, never accepted the Copenhagen interpretation, famously declaring against its probabilistic implications that "God does not play dice." The discussions between Bohr and Einstein, especially at two of the renowned series of Solvay Conferences in physics in 1927 and 1930, constituted one of the most-fundamental and inspired discussions between physicists in the 20th century (Mehra, 2012). For the rest of his life, Bohr worked to generalize complementarity as a guiding idea applying far beyond physics.

Niels Bohr has long been inseparably linked to the Copenhagen interpretation of quantum theory. Much credits were accorded to Bohr with his deep insight into the novel ways in which the quantum theory approaches the description of nature. Bohr, a Danish physicist made fundamental contributions to understanding atomic structure and quantum mechanics, for which he received the Nobel Prize in Physics in 1922. Bohr's notion of complementarity can be traced back to the *Laozi* which he would have read (Lee, 2017). In Yijing, the polar contrasts such as *yin* and *yang* are not regarded as mutually exclusive; but co-existing, co-present in each from a holistic *Whole*. Such a notion of metaphysics stood Bohr in good stead for characterising quantum phenomena which are at once both wave and particle. His notion of complementarity bears witness to the similarity of Yijing and quantum physics.

In a letter written by Bohr himself, discovered in 1998, which is a reply to a letter of inquiry from a Svend Hugo Jiirgensen, a teacher from the Danish town of Aalborg. The teacher had sent Bohr a manuscript entitled "Tuo Te Ching and the Idea of Complementarity". Bohr's reply, dated 26 March 1958 begins, "*I thank you for your letter and the enclosed little note about Tuo Te Ching, which I have read with great interest. I believe what you say about the old Chinese philosophy is in many ways quite to the point. In my youth I received a beautiful impression of it through Ernst Merller's book 'Oldmester', and at a visit to China twenty years ago I learned how highly the memory of Lao-Tzu is still valued.*" Since Merller's book was first published in 1909 (the year Bohr turned 24) and Bohr by his own account was in his youth when he was acquainted with Dao. It is clear that his knowledge of Chinese philosophy preceded his discovery of the complementarity principle in physics in 1928 (Allinson, 1998). Bohr, evidently, valued highly the ancient Chinese philosophy. The Yin/Yang complementarity including the way Yijing is interpretated are based on such similar principles, it is this exposure to the methodologies of interpretation in Yijing that could be instrumental or could have facilitated his conceptualization of the complementarity principle in physics, which has proved invaluable as an explanatory principle for quantum physics. Bohr's fascination with and feeling of identification with Chinese philosophy was profound to the extent that when Bohr was knighted he used the yin-yang symbol in his coat of arms and inscribed within it with these words "*Contraria sunt complementa"* which mean opposites are complementary (Fierke, 2019). This aligns with Yijing principle of duality and wave. Yijing is a body of knowledge derived at least three thousand years ago and dealt in the subject of quantum physics but in far lesser words and scientific rigor.

The great divide comes when the macroscopic world of reality differs from the microscopic interpretation of the sub-atomic world. The behaviours of the particles cannot fit the principles of the classical physics and the Copenhagen Interpretation (around the period 1925-1927) came forth to conveniently pack these unknown patterns into the theory of quantum mechanics. The Copenhagen interpretation was the first general attempt to understand the world of atoms as this was represented by quantum mechanics. The group of wise men included Niels Bohr, but also Werner Heisenberg, Max Born and other physicists made important contributions to the overall understanding of the atomic world that was associated with the name of the capital of Denmark (Li & Li, 2005).

The Copenhagen Interpretation has three primary considerations:

- The wave function is a complete description of a wave/particle. wave-particle duality is a manifestation of quantum entities (Allori, 2015).
- When a measurement of the wave/particle is made, its wave function collapses. In the case of momentum, a wave packet is made of many waves each with its own momentum value. Observation with measurement reduced the wave packet to a single wave and a single momentum (Allori, 2015).
- If two properties are related by an uncertainty relation, no measurement can simultaneously determine both properties to a precision greater than the uncertainty relation allows. When a wave/particles position is measured, its momentum becomes uncertain (Storey et al., 1994).

There is no intuitively easier way to understand the meaning since it is a great departure from the deterministic and predictability of classical physics that are obvious and observable. The quantum interconnectedness, entanglements, uncertainties, non-linearity, far from equilibrium state actually rule our realities. Such a way of looking helps to shape new directions of theoretical development, involving new concepts and new ways of understanding the basic nature of matter, space, time. There exists an external atomic world, whose properties are independent of any individual human and indeed of humanity as a whole; that these properties are encoded in eternal physical laws; and that human can obtain reliable, albeit imperfect and tentative, knowledge of these laws by eschewing the objective procedures and

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epistemological strictures prescribed by the (so-called) scientific method (Sokal, 1996). The dogmatic regime imposed by the long post-Enlightenment hegemony by the Western intellectual outlook find lesser harmonization when the discoveries come to the particle-level science in microcosm.

Since Copenhagen Interpretation, there is deep conceptual shifts within twentieth-century science and this has undermined Cartesian-Newtonian science. What was deemed as mystifying in Yijing, used as divination and predictive tool- which is a mathematical construct in the study of probability waves and their interactions with other corresponding wave in the specific space-time is unravelled as science. Quantum science revelations have demystified substantive contents in Yijing framework which will be explained in subsequent sections in this paper.

With these considerations, this paper is making an attempt to draw the line in the demystification of Yijing with reference to modern quantum science and their related theories and principles. As such, these theories may still give imaginative and intuitive insight into a situation for which there is at present no other way to obtain this kind of insight. It is in such a spirit that this present paper will frame its discussions- that it is not attempting to make statements and to profess that the metaphysical part of Yijing is the same as quantum physics or what actually is the nature of reality, but rather this paper is merely looking at certain imaginative and intuitive concepts to see what these relatedness can shed on the new discoveries in quantum interconnectedness. Copenhagen interpretation is mostly regarded as synonymous with indeterminism, Bohr's correspondence principle, Born's statistical interpretation of the wave function (Born, 1955), and Bohr's complementarity interpretation of certain atomic phenomena (Zalta, 2019) (Jan, 2019).

Since 1687 with Newton's Principia, classical physics started to be framed in deterministic way in a "clock-work universe", Newtonian science took roots to define scientific worldview. The Principia is a work of physics that brilliantly presents the three laws of motion (Snobelen, 2010). After three centuries, the quantum science discovery with the Copenhagen Interpretation in 1927- a monumental year in the development of quantum physics; though major disagreements emerged between Bohr and Heisenberg concerning the interpretation of quantum physics, the interpretations, nonetheless split ways. Classical physics and quantum science, separated in directions (Pospiech, 2000). The conceptual framework of quantum mechanics is supported by massive amount of experimental data and these divergent views forces physicists to express themselves in very indeterminate ways, very much in the language of Yijing – polarity and complementarity (ying-yang) with wave-like and particle-like attributes, non-linearity (Taichi diagram), entanglements (the interactions involving the law of causality) and the far-from-equilibrium vibration (constant wobbling to stay centred).

COMPLEMENTARITY

In classical physics, a particle can only be a particle, with no duality feature because it is antithetical to the principle of locality and determinism (Fierke, 2019).

Most of the challenges in comprehending quantum theory arise from trying to develop quantum theory with classical concept and framework and then explaining the differences- to explain the peculiarities of quantum theory in relation to the classical concepts position and momentum or to the duality of wave and particle (Pospiech, 2000). The classical assumptions that a particle has a path, position, and velocity that exists independently is challenged.

Rather phenomena arise from interactions between the observer and the observed, or indeed can be seen as the interaction itself. The observer and observed are inter-related in a real and fundamental sense. How can mutually exclusive behaviour like wave-like and particle-like be properties of one and the same light? They are not the properties of light. They are the properties of the interaction with light, between the observer and the observed light. Wave-like behaviour and particle-like behaviours are therefore properties of the interactions (Zukav, 2012).

David Bohm and Henry Stapp (David Bohm & Stapp, 1994) stated: "*Normally the double-slit experience is described near the beginning of a course in quantum theory and is used to justify the claim that quantum phenomena are not comprehensible in terms of ordinary mechanical ideas. It is argued on the basis of this example that a single quantum entity such as a photon or electron behaves sometimes like a particle and sometimes like a wave and that a new way of thinking is needed to cope with this bizarre schizophrenic character of quantum objects*" The constant fluctuation between particle and wave expresses a relationship of complementarity, which suggests that opposites are at one and the same time mutually implicated and mutually exclusive (similar to the yin/yang symbol where there is yin in the yang and yang in the ying, see Figure 1). Joining the two ideas, mutually implicated and mutually exclusive becomes like an anti-epistemological revolution of modern science. The principle and then the framework of complementarity were developed by Bohr in order to account for the indeterminacy of quantum systems and to describe comprehensively, but without classical synthesis their conflicting aspects (Plotnitsky, 1994). Bohr's principle provoked the equivalent of an epistemological earthquake and overturned the order of knowledge in classical physics. Bohr's "epistemological earthquake" implicates the role of the observer, including the apparatus of observation, in what is measured and thus known.

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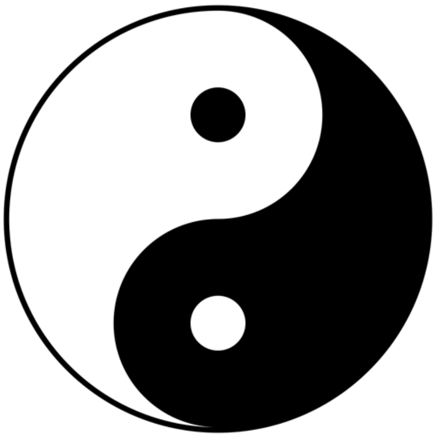

Figure 1

Bohr's discovery highlighted the interaction between the observer and the external world and the interactions and intervention at every stage of observation and including the way and manner the observation is described and framed in a language. There is a certain entanglement. "Phenomenon" as Bohr described includes the observed object, the clinically, unambiguous result of the observation with descriptions of the conditions of the apparatus or experiment to derive the outcomes. There is no straightforward relationship between language and measurement as they are integrally linked and meshed. Language, in its fullest descriptions, does not represent the world "as it is", nor do measurements represent a deterministic exactitude independent of the observed object itself. Language, measurement, as well as the observer, are part of the same whole, which is a radical shift from the assumptions of Newtonian physics and Cartesian epistemology (Fierke, 2019). Bohr's discovery significantly reworks understandings of space, time, matter, causality, agency, subjectivity and objectivity and mostly on the same page as Yijing's worldview.

In the region of atomic physics there appears new formalisms that do not fit into the frame of the ordinary causal descriptions. The discovery of the quantum phenomenon has disconnected us from the classical physics we came to know including the theory of relativity, only retains its relevance, applicability and adequacy only as long as the quantities of action entering into the description are large compared to Planck's quantum (Cuffaro, 2010). The complementarity phenomenon is therefore "Planck's quantum" dependent *"... the ideal of causality that the behaviour of a physical object relative to a given system of coordinates is uniquely determined, quite independently of whether it is observed or not.*" (Niels Bohr, 1937)

"*Not only is the well-known dilemma between the corpuscular and undulatory character of light and matter avoidable only by means of the viewpoint of complementarity, but the peculiar stability properties of atomic structures which are in obvious contrast with the properties of any mechanical model, but which are so intrinsically connected with the existence of the quantum of action, form the very condition for the existence of the objects and measuring instruments, with the behaviour of which classical physics is concerned.*" (Niels Bohr, 1937)

Bohr further added: *"... the paradoxes of atomic physics could be solved not by a one sided attitude towards the old problem of "determinism or indeterminism" but only by examining the possibilities of observation.*" (Niels Bohr, 1937)

After the EPR (Fine, 2014) paper Bohr spoke about Heisenberg's "indeterminacy relation" pointing to the ontological consequences of Heisenberg's claim that kinematic and dynamic variables are inadequately defined unless they were referencing to an experimental outcome. Bohr challenged Heisenberg's "uncertainty relation" on its epistemological limitation.

Complementarity is a semantic that still needs epistemological and ontological justifications. Bohr's view was that the truth conditions of sentences ascribing certain kinematic or dynamic value to an atomic object are dependent on the apparatus involved, in such a way that these truth conditions have to include reference to the experimental setup as well as the actual outcome of the experiment. From a classical point of view, something is 'missing' from the description of the observation. What is 'missing', according to Bohr, is a clear distinction between the experimental apparatus and the object of investigations; the 'agency of observation' is, in some sense, a part of the phenomenon (Cuffaro, 2010).

Bohr expresses all of the foregoing in the following concise paragraph: "*Now the quantum postulate implies that any observation of atomic phenomena will involve an interaction with the agency of observation not to be neglected. Accordingly, an independent reality in the ordinary physical sense can neither be ascribed to the phenomena nor to the agencies of observation. After all, the concept of observation is in so far arbitrary as it depends upon which objects are included in the system to be observed. Ultimately every observation can of course be reduced to our sense perceptions. The circumstance, however, that in interpreting observations use has always to be made of theoretical notions, entails that for every particular case it is a question of convenience at what point the concept of observation involving the quantum postulate with its inherent 'irrationality' is brought in. This situation has far- reaching consequences. On one hand, the definition of the state of a physical system, as ordinarily understood, claims the elimination of all external disturbances. But in that case, according to the quantum postulate, any observation will be impossible, and above all, the concepts of space and time lose their immediate sense. On the other hand, if in order to make observation possible we permit certain interactions with suitable agencies of measurement, not belonging to the system, an unambiguous definition of the state of the system is naturally no longer possible.*" (Bohr, 1928).

WAVES AND QUANTA

The quantum relation in which energy = *Planck constant* x frequency and energy = mc^2 *(speed of light),* both these when linked implied within those equation's definitions that matter is directly proportionate to its frequency. An observer bound to the matter will associate with it a frequency determined by its internal energy which is its "mass at rest" (De Broglie, 1923). De Broglie's advocacy is that matter has waves which "correspond" to it.

Matter waves were discovered in the early 20th century from their wavelength, predicted by De Broglie, Planck's constant divided by the particle's momentum (Ellman, 1998).

(Energy) E = (mass) m x (speed of light) c^2
(Energy) E = (Planck constant) h x (frequency) f

$m\, c^2 = h.f$

$m = (h.f)/ c^2$, *since* c= *(wavelength)* λ x (frequency) f
$m=(h.f)/ c\ .\ \lambda\ .\ f$
$m=h/ c\ .\ \lambda$
$\lambda = h/ m.c$

De Broglie, therefore hypothesized that the wave aspect of a particle of matter should have an analogous wavelength, λ:

$\lambda = h/ m.c = h/$ *particle momentum.*

In summary, using simple equations of Planck and Eintein, De Broglie derived his findings (Zukav, 2012).

1. Wavelength of the "matter wave" corresponds to matter ($m=h/ c\ .\ \lambda$)
2. The greater the momentum of a particle, the shorter is the length of its associated wave. ($\lambda = h/ m.c = h/$ *particle momentum)*

In Dao, all matters arise from energy (qi) and this qi propagates like wave (ÁngelInchauspe, 2016). In Daodejing, by Laozi, is a 81chapters classics interpreting the traditional Chinese natural cosmology via the focus and field theory (Chang, 2017), particular in the discussion of Dao and its behaviour likened to water (wave-line properties) (*referred in Chapter 8 of Daodejing*). Laozi, considered as the first Chinese philosopher, was well-known for his works Daodejing and its interpretations relate to Yijing.

In Chapter 25 of Daodejing (Laozi, 2015):

"*Something existed unformed yet complete, Before heaven and earth were created (before matter is formed). Silent! Empty! Standing alone, not changing. It (refer to energy, without mass yet) circulates everywhere (propagation and diffusing with wave-like properties), and causes no danger. It can be considered the mother of the world (all matter, organic or inorganic, arising from the same sub-atomic particles hence the mother of the world because they are made of the same particles).*

I do not know its name; Its symbol is called Dao. If I tried to make its name, I would call it great. Being great speaks of departing. Departing speaks of being remote. Being remote speaks of returning (circulatory properties, up and down, in a circle or can be as a sine-curve with wave properties). Dao is great, Heaven is great, Earth is great, The king is also great. Within the realm exist four that are great, And the king resides as one of them!

People follow the earth. The earth follows heaven. Heaven follows Dao. Dao follows what is naturally so (of certain frequency and wavelength from matter of the earth).

YIJING CONSTRUCT AND RELEVANCE TO QUANTUM MECHANICS

The ancient Chinese book Yijing or I-Ching or usually called the Book of Changes. Yijing's from ancient texts named Fuxi as the originator and Fuxi was recognized by the Chinese as one of the "Three Sovereigns" in the early patriarchal society in China (c. 2,600 BCE). Fuxi is counted as the first Three Sovereigns at the beginning of the Chinese dynastic period.

Yijing introduces a system of symbols -Yin (represented by broken lines - -, or "0" in binary terms, denoting negative charge) and Yang (represented by -, or "1" in binary terms denoting positive charge). Originally, Yijing is deemed a divination manual in the Western Zhou period and over the course of the Warring States period and early imperial period (500–200 BC) it was transformed into a cosmological text with a series of philosophical commentaries known as the "Ten Wings" penned by Confucius and his disciples (Smith & Lianzhang, 1991) Yijing is institutionalized as part of the Five Classics (Nylan, 2008) and is considered a ranking first book of the Five Classics. Yijing has become the subject of scholarly commentary and the basis for divination practice for centuries across the Far East, and eventually took on an influential role in Western understanding of Eastern thought. Out of the mysticism surrounding Yijing and the bewildering patterns that emerged from the study of the hexagram structures for predicting the future (in management terms, scenario building), the linguistic and structural features of the hexagrams (being a sign-system) bring about questions of ambiguity, obscurity and indeterminacy. Yijing's system is based on the following principles – indeterminacy (Busch, 1985) , non-linearity (non-locality) (Bohm et al., 1987) , entanglements (Barad, 2010) and complementarity (Pospiech, 2000) which are what quantum science's weird phenomenon are all about.

It begins with the introduction of a system of symbols Yin and Yang (equivalents of 0 and 1). It had a powerful impact on culture, medicine and science of ancient China and several other countries. A predecessor of the idea of binary numeration system, Gottfried Leibniz (1646–1716) was one of the great thinkers of the seventeenth and eighteenth centuries made deep and important contributions to the fields of metaphysics, epistemology, logic, philosophy of religion, as well as mathematics, physics, geology, jurisprudence, and history (Brandon C., 2017). The Yijing/ binary system is

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aligned and similar in their mathematical articulation. Leibniz' discovery of the binary number system in the sixty-four-hexagram Fu Xi Yijing has interesting similarities with the double geometric progression methods. *See Figure 2*.

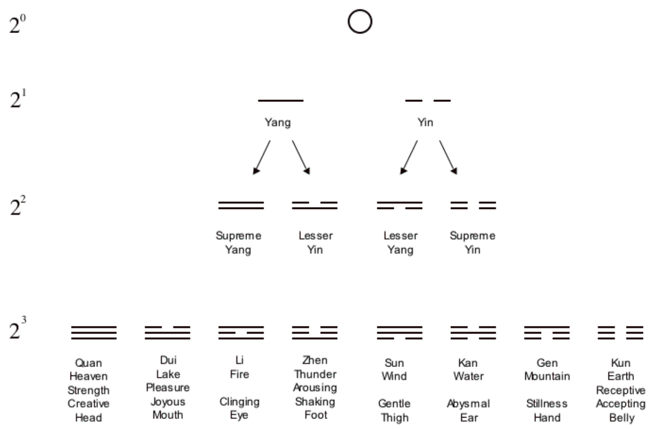

Figure 2, The expansion of the geometric series from 0, 2, 4, 8 and then to eventually the 64 of the double stacked hexagram.
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Leibniz developed the concept of binary system and was amazed by a similarity of this table of 64 hexagrams with his own thoughts when he became acquainted with it. Leibniz has seen in this similarity the evidence of the pre-established harmony and unity of the divine plan (Hu et al., 2017). From 2 (one yin '- -' and one yang '-'), 4 bigrams, 8 trigrams and 64 hexagrams of the Yijing. The 8 trigrams in the bagua can be represented by such "0" and "1" descriptors.

000 (Kun), 001 (Gen), 010 (Kan), 011 (Xun), 100 (Zhen), 101 (Li), 110 (Dui), 111 (Qian). *See Figure 3*.

Figure 3, Pre-Heaven Bagua (left), Post-Heaven Bagua (right)
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From a modern mathematical standpoint, Yijing features the dyadic groups of binary numbers which is to contain all the universal probabilities in nature for all circumstances and situations under Heaven (Qian) and Earth (Kun). See Figure 3, the Pre-Heaven bagua contains guas or trigrams with opposing charges:

Chien +/ Kun –
Zhen +/ Xun –
Kan +/ Li –
Ken +/ Dui –

Each pair of the trigrams in the pre-Heaven arrangement will negate and neutralize each other to come to a state of equilibrium. The pre-Heaven bagua is in a state of equilibrium but with energy (qi) infusion the trigrams will re-align to the post-Heaven configuration in a state of activities. Pre-Heaven represents a state of stability while post- Heaven represents a state of actions/ chaos. Thus, there is a constant tug and oscillation between state of stability, which is transient and state of chaos finding equilibrium- always in search of equilibrium and stability. This is the relationship between the pre-Heaven and post-Heaven configurations. In between the oscillation from state of rest and equilibrium in pre-Heaven state, in the quantum terms, certain kinematic or dynamic value is applied to an atomic object or particle for it to move to the post-Heave state of actions.

The system of Yijing is represented by the tables with dyadic groups of 4 bigrams, 8 trigrams and 64 hexagrams, which embrace all state of probabilities under Heaven and Earth and are the fundamental archetypes of Nature and are everything from the dust of the world (inorganic matter) to the ten thousand creatures (organic and living). In Daodejing, Chapter 4 (Laozi, 2015):

"*Dao is like a cup or bowl, yet use it and there exists no need to fill it.*
Profound and deep!, it appears to be the ancestor of the ten thousand creatures.
It blunts their sharpness, Loosens their tangles, Softens their brightness, Makes them the same as the dust of the world.
Deep and profound!, it seems to barely exist. I do not know whose child it is – Its image came before that of god."

The old Chinese sages Fuxi, Wenwang or Confucius would not know have been acquainted with the genetic code of protein sequences of amino acids but this code is organized in a way that is very much in accordance with Yijing; in particularly, the genetic code in the DNA molecules is built on using 4 nitrogenous bases, 16 doublets, and 64 triplets. The application of dyadic groups as a foundation of the bio-mathematical construction of the geno-logical coding, which exists in parallel with the known genetic code of amino acids but has a different purpose- to code the inherited algorithmic processes using the logical holography and the spectral logic of systems of genetic Boolean functions (Hu et al., 2017). The indeterminacy of the Yijing applies at the organic level to produce the "ten thousand creatures" and the inorganic "dust of the world". The organic or inorganic matters have within them the same sub-atomic particles carrying the same wavelengths and vibrational notes.

As a binary system, Yijing is based on 2 to the sixth power (2^6), or 64. This is the basic structure of the Yijing. Each hexagram has six lines, each line represents an aspect of the hexagram it is in, and so there are 64 x 6 situational aspects in the book, or 384 lines. Change happens and each hexagram will change to another and the probability is either 0 line change, 1 line change, 2 lines change, 3 lines change, 4 lines change, 5 lines change or all lines change to another hexagram. When there are 64 hexagrams and each is to change to another under the above change conditions (0 line change to all lines change), there will be 64 x 64 combination of changes which is 4096. Any one of the 64 hexagrams changes to either one of the 64 hexagrams, there are hence 4096 possible outcomes which will represent the universal set of all contexts, frames of references, relationships, possibilities and all situations under Heaven and Earth. The universality of the Yijing, through the 384 lines, explains and addresses all possible situations, contexts and situations under Heaven and Earth through probabilistic computation. Every hexagram is posited in a space-time coordinate. A string of hexagrams represents the state of reality in that time period. *See Figure 4.*

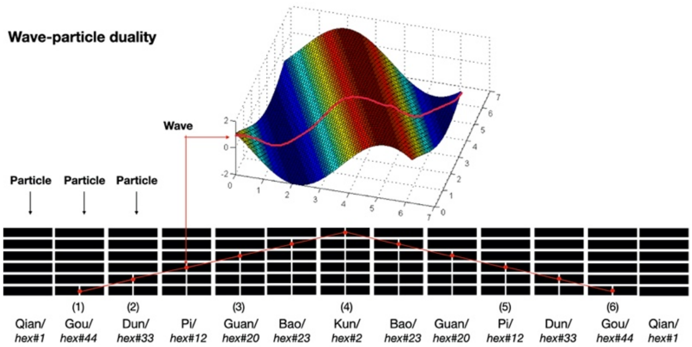

Figure 4, Wave-particle duality/ hexagram-wave duality

The Schrödinger Wave Equation

- The Schrödinger wave equation in its time-dependent form for a particle of energy *E* moving in a potential *V* in one dimension is

$$i\hbar\frac{\partial\Psi(x,t)}{\partial t}=-\frac{\hbar^2}{2m}\frac{\partial^2\Psi(x,t)}{\partial x^2}+V\Psi(x,t)$$

- The solution (wave function) is not restricted to being real. Only the physically measurable quantities must be real. These include the probability, momentum and energy.

The equation include values of Planck constant, wave function defined over space and time and mass. According to Max Born, the German physicist on the interpretation of subatomic phenomenon. According to him, it is not necessary or possible to visualize these waves because they are not real and are only probability waves. The whole course of events is determined by the law of probability; to a state in space there corresponds a definite probability (Zukav, 2012). Yijing is premised on this same principle of probability. Born further added: "*Physics is in the nature of the case indeterminate, and therefore the affair of statistics*." Again to quote Born: " *The motion of particles conforms to the laws of probability but the probability itself is propagated in accordance to the law of causality*." (Bearden, 1975)

Within the 64 hexagrams with a stack of 6 lines (yin or yang), the distribution of the ying and yang lines in the hexagram
zero-*yang* (1 hexagram)
one-*yang* (6 hexagrams)
two-*yang*(15 hexagrams)
three-*yang* (20 hexagrams)
four-*yang* (15 hexagrams)
five-*yang* (6 hexagrams)
six-*yang* (1 hexagram).

Changing lines	*Possible outcomes*
0	64
1	384
2	960
3	1280
4	960
5	384
6	64
Total	4096

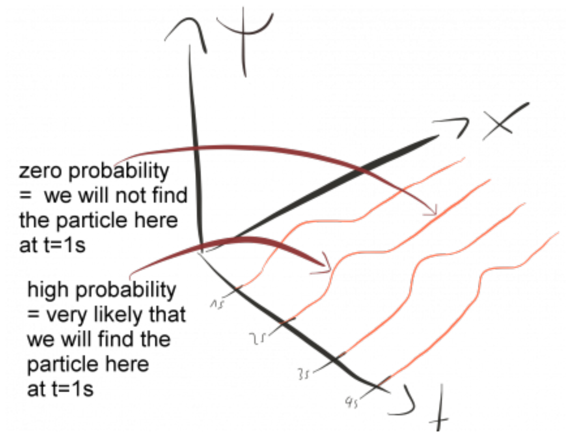

Figure 5, Probability Schrödinger *wave*
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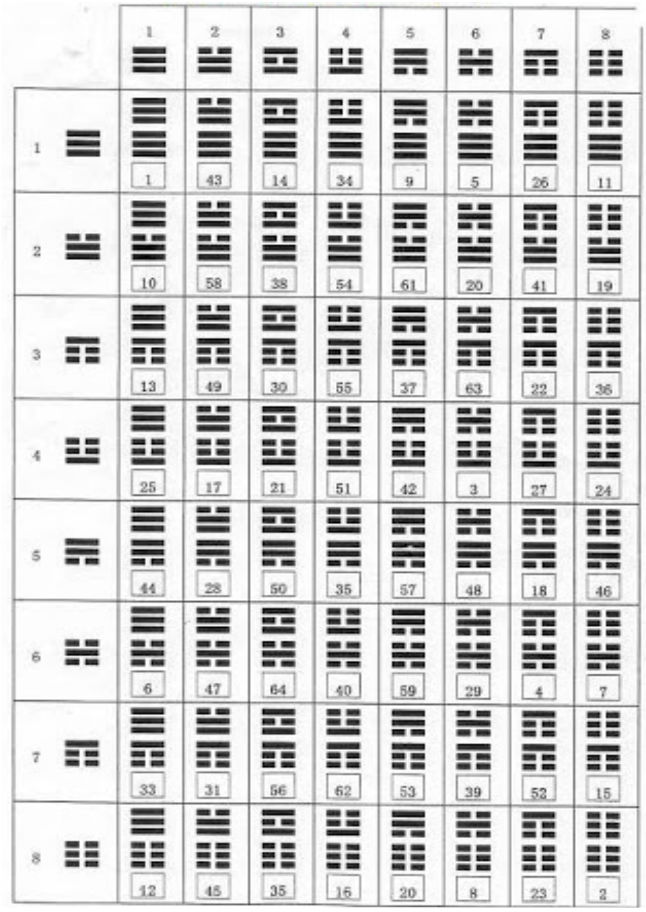

Figure 6, 64 hexagram in Fuxi's sequence
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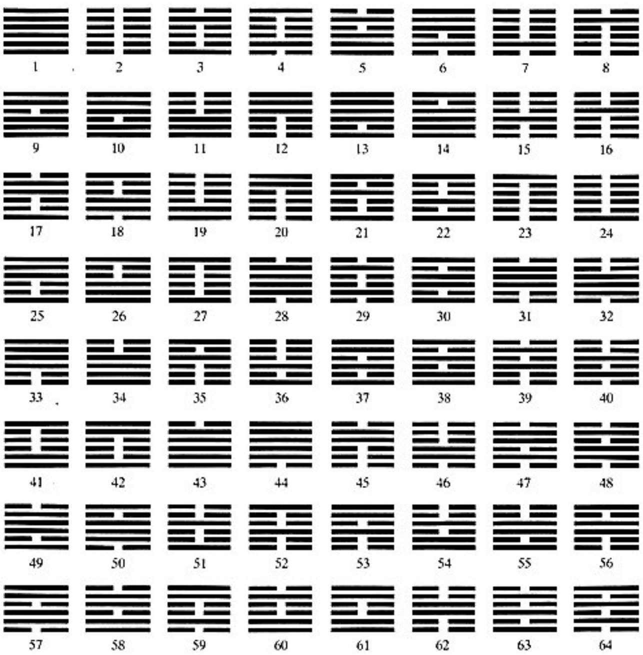

Figure 7, 64 hexagram table with the anointed hex#

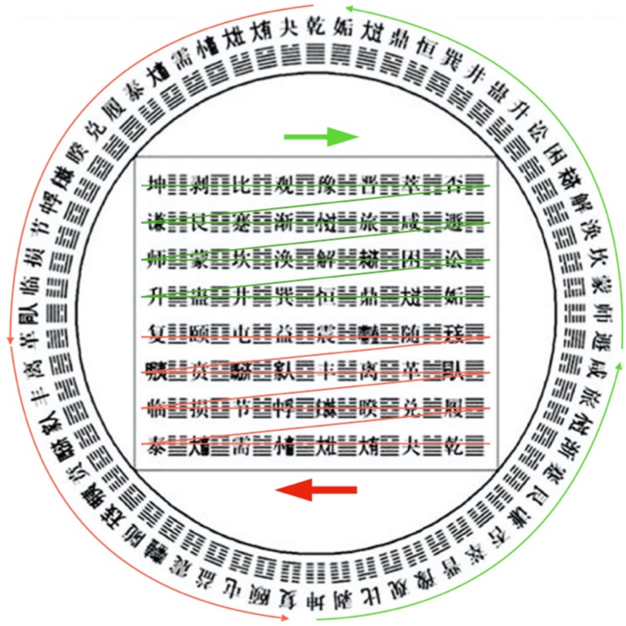

Figure 8, Heaven(Circle)-Earth (Square) representation of the 64 hexagrams based on the Fuxi sequence with unique patterning demonstrating non-linearity on earth while the Heaven exhibits the circulatory pattern.

In the table of 64 hexagrams, 8 trigrams (Qian(1)- Dui(2)- Li(3)- Zhen(4)- Xun(5)- Kan(6)- Gen(7)- Kun(8) indicate its rows and this same sequence applies to the columns. Each of hexagrams is a stack of 2 trigrams: the trigram of its row and the trigram of its column.

Figure 6 is laid in the Fuxi's sequence (*the number at each gua represent the hex# which is shown in Figure 5*). In Figure 7, it's the logical sequence of the hexagram arrangement where each pair *e.g. hex#3/ hex4, hex5/ hex#6, hex#63/ hex#64 are 180 degree rotated (rotational relationship between pairs)*. There are 4 pair exceptions *hex#1/ hex#2, hex#27/ hex#28, hex#29/ hex#30, hex#61/ hex#62, the change of yang to yin and yin to yang respectively for each line in the hexagram*.

Figure 8, is an illustration of non-linearity in the way the hexagrams are positioned in the square table. The "Z" pattern layout in the square represents movement in the space of "Earth" The circle embracing the square, represents Heaven and in that arrangement, a circulatory pattern emerges. Figure 1 ying-yang symbol also shows the "wavy line" non-linear propagation pattern. This diagram in Figure 8 should be visualized as three-dimensional where the square represents the plane of the earth and the circle the entire universe of probabilities waves described through the 64 hexagrams in the circle.

Every hexagram is related to one another and can permute in form and structure to either 1 of 64 within the matrix of 8 x 8 hence each hexagram is entangled in one way or another by the changing of its lines. Such entanglements occurs when the lines within the hexagrams change from one state to another. Or when a pair or group of hexagrams are generated, interact or share spatial proximity in a way such that exhibit similar line structures, though separated spatially but are generated and changed at the same time. Despite the spatial separation, even with great distances separating the pair or group of hexagrams and when the measurements are performed simultaneously, the generation of the same hexagram structure appearing to affect the state of system in the other location is the "spooky action at a distance" as Einstein called it.

Entangement, non-linearity, indeterminism, probability waves, complementarity are the rules in Yijing.

CONCLUSION

One should note that Yijing was written three thousand years before the occurrence of modern Academies of sciences and comparing it with the Copenhagen Interpretation is not an exercise just to draw any parallels or relatedness but to show that in the research of sciences, particularly quantum science, a divergent from classical physics occur. Indeterminism, complementarity, probability interpretation , uncertainty principle, entanglement, superposition are not terms generally acceptable in classical physics up until the Copenhagen Interpretation. Yijing's framework and applications encapsulate and embrace uncertainties, entanglement, probability waves and complementarity. From the period of 1925 right up to the 60s, Copenhagen Interpretation was itself a hotbed of debates. A deeper understanding of the important disagreements within the "Copenhagen school" as what constitutes the real and authentic Copenhagen interpretation is necessary (Camilleri, 2009). The western academic science and its scientific laws were developed without any connection with Yijing and such concurrences of the weirdness and spookiness phenomenon between the two should be researched and studied more seriously, with the myths of Yijing delayered.

At Copenhagen, the physicists accepted quantum physics as a complete theory without much elaboration on the weirdness and that quantum mechanics predicate on the prediction of probabilities and not on actual events. Quantum mechanics relates to experience. Quantum mechanics, according to the pragmatists, all, science is the study of correlations between experiences. De Broglie's equation correctly correlates experiences (Zukav, 2012).

De Broglie's matter-wave theory in 1924 shaped the form of quantum mechanics and took the forms of what it essentially is today. The worldview of Newtonian physics and the common sensical large-body, observable phenomenon is totally debunked at the atomic region of space (Zukav, 2012). Quantum science at the atomic region is all about uncertainty, probability, entanglement, complementarity and this is explained in Yijing three thousand years ago. Yijing's worldview must be researched with the rigor of modern science, demystified.

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About The Author: David Leong, *PhD* started his entrepreneurial ventures early, soon after he graduated from the National University of Singapore in 1994 with a Bachelor of Business Administration degree. He has founded various ventures from corporate finance, business consultancy, design consultancy, human resources (HR), publication and technology.

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