Quantum Mechanics: Applied to Consciousness

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Quantum Mechanics is the most collective intellectual discovery ever made that governs the dynamics of atomic and subatomic domains. It is conceptually alien from the deterministic, linear, objective philosophy of the Classical Physics and the Theory of Relativity proposing an indeterministic, chaotic, measurement generated phenomena without a causal structure.[1] Therefore scientists like Einstein, Schroedinger, Planck, de Broglie all objected, tried to show the incompleteness and fragility of QM by proposing thought experiments and tried to evolve alternative interpretations that led to the division in physics known as quantum schism. However, the experimental results reinforced the Copenhagen interpretation though it could not give a total conceptual clarity. The difficulty in completely integrating the theory of relativity and quantum mechanics, namely relativizing the quantum and quantizing the relativity through the field theories in explaining problems like big bang exhibits the foundational problems in physics. There is a conceptual ambiguity underpinning QM which the philosophically minded scientists try to overcome through new interpretations.

From time immemorial, man reflected on the processes of knowing and the tools of sensing, thus creating myths, stories and

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theories and evolving practical transformational techniques to live meaningfully. Some of the rituals practiced among the Red Indians, of the Maoris of Australia, Tribal African cultures and the many other cultures exhibit these primordial concerns. In the East as well in the West the search for the above mentioned questions led different styles of understanding. In the East, through a religious and spiritual understanding, consciousness binds body, mind and soul and developed tools of transformation like yoga through meditation in which Buddhism contributed immensely. In the West, the body-soul bonding was interpreted in terms of the philosophy of Plato while Aristotle gave a more biological explanation which later was integrated into the religious understanding of Christianity leading towards contemplative and experiential practices. During the period of enlightenment and further Modernity, philosophical and scientific developments like the Cartesian division of body and mind led to various theories of mind and matter. However, due to the ascendency of the scientific materialism, a reductionist approach came to the ascendency rejecting the mind as mere functions of the brain and lately reducing cognition in terms of neurons and its networking in an attempt to invent artificial intelligence paving the way for computers, robots and to trans-human like cyborgs.

Thus, the search for understanding the body-mind interrelationship or the consciousness studies both from the perspective of the East and the West lead to practical applications and transformation of consciousness into higher states of efficiency. These two disciplines, QM and Consciousness Studies, joined together as Quantum Consciousness will be the best tool for researching on the still ambiguous reality called consciousness in terms of scientific, philosophical and religious perspectives, which can definitely create best tools of transformation of consciousness by going deeper into the realms of both matter and spirit.

The Challenges of Quantum Mechanics

Quantum Mechanics (QM) is the greatest collective intellectual effort developed by Max Planck, Niels Bohr, Werner Heisenberg, Louis de Broglie, Albert Einstein, Erwin Schoredinger, Max Born, Paul Dirac, Enrico Fermi, David Hilbert, Satyendra Nath Bose, Arnold Sommerfeld, ECG Sudarshan and many other physicists and mathematicians. QM is the fundamental theory of modern

physics which explains the behaviour of matter and energy. The predictions of QM vary drastically from that of classical mechanics at the atomic and subatomic levels. Furthermore, the philosophical foundations of QM are entirely different from that of the Classical Physics which describes the physical reality in its ordinary and macroscopic level. Though the fundamentals of QM were developed in the late 1920s, still there exists a lot of debate about it, because the concepts and predictions that are brought by QM are difficult to digest. Richard Feynman comments: "I think that I can safely say that nobody understands quantum mechanics." Focusing on the fact that only the physical reality can be observed, Niels Bohr explicates the intricacies linked to QM. Although the particles are real, the wave function which completely describes the particle is not real and gives only a probability of a presence, and hence cannot have any physical interpretation. A particle exists in all states at once until a measurement is made and the particle is observed. This is also known as Copenhagen interpretation which attempts to explain the foundational aspects of QM. The Copenhagen interpretation was developed primarily by Neils Bohr and Werner Heisenberg. Max Born, Wolfgang Pauli and some other physicists who were in support of this interpretation; however Albert Einstein, Erwin Schroedinger, Louis de Broglie, Max Planck, David Bohm et al had serious reservations towards this view. Einstein's disagreement is visible in the question: "Do you really think the moon isn't there if you aren't looking at it?" 1n 1935, Einstein along with Boris Podolsky and Nathan Rosen (known as EPR) concluded that quantum mechanics was not a complete theory by proposing the EPR thought experiment. According to them particles must have definite states even if they are not measured (hidden variables). In 1952, David Bohm constructed a consistent theory of QM allowing for hidden variables which with the assistance of the physicist mathematician Basil Hiley, developed the ontological interpretation even into Quantum Field theory with the aid of Clifford algebra. In 1964, John Bell observing the denial of a different interpretation than the Copenhagen one and the Bohm's presentation of the Ontological interpretation, came up with his famous paper which presents a mathematical formulation of locality and realism claiming that in some cases it would be inconsistent with the predictions of the QM. However experiments demonstrate convincingly that the predictions of the

QM are correct! Till date, QM stands firm on experimental grounds. Any attempt to falsify it has suffered a setback.

Quantization of Energy

Most of the scientists in the beginning of the twentieth century believed that simply by applying the Newtonian Mechanics to phenomena could solve all most all of the problems in the world. This euphoria about the conquest of science was depicted by the ironic comment of Lord Kelvin that "there is nothing new to be discovered in physics now. All that remains is more and more precise measurement". Within a few decades this euphoria was eroded by the discoveries of Quantum Mechanics that describes the dynamics of the microscopic bodies while the Theory of Relativity unfolding the immensity of the universe. However, these two theories are difficult to be integrated, namely to quantize relativity and to relativize quantum and scientists are looking towards new theories that could bring them together so that phenomena like the big bang and consciousness could be explained.

In Quantum Mechanics, we find man at his best in his role as `seeker'. Here we find him grappling with the eternal problem of the ultimate nature of reality. This problem has been haunting scientists ever since thought was born. In the East by Kanada and in the West Democritus asked the question about the nature of reality and came up with the solution that all material reality is composed of atoms. However, through a metaphysical speculation, Aristotle denied the existence of atoms which meant indivisible until it was reintroduced by Dalton and Avogadro. From the beginning of the twentieth century, studies on atoms have broken down the atoms into innumerable particles and at present into the three pairs of quarks namely up-down, charm-strange, truth-beauty brought together by three forces of nature such as strong, electroweak and gravitational forces governed by Quantum Mechanics. Thus, Quantum Mechanics describes and defines the interactions among the microscopic world. is a successful attempt in unraveling this mysterious problem.

Max Plank was the physicist who brought forth the first crucial Idea of QM in 1900, December 14. Most physicists of the day conceived nature as a continuum. They thought that the forms of matter blended into one another in a smooth and continuous way. This continuous view has been replaced by Plank with a discrete

one. The discreteness of physical quantities can be explained in terms of a pile of wheat heap observed from a distance; it may appear to be a continuous smooth hill. But when observed closely one can recognize the illusion and see that in fact it is made up of tiny grains. These discrete grains are the quanta of the pile of wheat. Another example might be of the reproduction of photographs in a newspaper photo; on close observation it consists of lots of tiny clots. The image has been `quantized' something you do not notice it if you are looking from far.

Plank was struggling with the problem of black body radiation. What is a black body radiation? Take a metal bar and put it into dark, light tight room. The metal bar is the black body, ie you cannot see it. If you heat the bar room it cause to be black, instead glowing a dark red like a burning coal. If you heat it to a still higher temperature the meal glows white hot. The light coming out from the hot metal in a dark room has a distribution of colours which can be measured, resulting in what is called the black body radiation curve. Plank proposed that the amount of discreteness by a number `*h*' which has been later called as Plank's constant. It specified like the size of a single grain in the pile of the wheat. Plank proposed that the absorption or emission of heat is equal and it is in terms of integral multiples of *h*, where *h* has the value of $6.62606957 \times 10^{-34}$ m^2 kg / s. Only after many years of hard work, Plank could arrive at his proposal of energy absorption and emission in terms of the discrete energy called quantum of action terms as Planck's constant. Quantum is the smallest divisible element of energy, denoted by *h*.

Quantization of Radiation

Plank's quantum of action was taken up by Einstein in order to explain the photo electric effect for which he got the Nobel Prize in 1921. If a beam of light shines on a metal surface like Germanium or Selenium, electrons will be emitted from the outer shells of the atoms on the surface causing a flow of electricity which could be detected an instrument. Einstein in his paper extended the concept of the quantum of action in order to explain the photo-electric effect and extended it to all types of radiation. Thus, Einstein interpreted that light as composed of photons and the electrons absorb integral multiples of h and liberate itself from nucleus, creating a flow of electrons which we call as electricity. He went beyond Plank to make the radical assumption that light itself was quantized into particles

called photons. Moreover Einstein held against the conservative view of Planck that the quantum concept could be reconciled with the Classical Physics. Einstein proposed that Quantum Mechanics needs a break from the classical concepts and should develop into a new theory. It is ironical that later Einstein fought against this vision in proposing thought experiments to show the incompleteness of QM.

Quantization of Space

By the end of the nineteenth century a great number of puzzling properties of matter were discovered when the scientists were able to make direct contact with the atomic processes. Roentgen discovered the penetrating X-rays in 1895, Henry Becquerel discovered radioactivity in 1896; and the Curies isolated radium in 1898. The experimental scientist J.J.Thomson discovered the elementary particle electron. The discovery of the spectral lines of light also puzzled them. If a substance is heated or an electric current passed through a gas of atoms, the substance or the gas will emit light. If the spectrum of the light is analyzed by a prism that splits of various colours, only definite colour lines appear in the spectrum. Each chemical element has a definite and unique set of coloured lines, called its line spectrum. No one had any explanation for this phenomenon in the nineteenth century. But this was the secret path to and interiority of matter.

At Manchester in England, Ernest Rutherford an experimental scientist of the first order was leading a team of scientists in their effort to understand the inert nature of matter by alpha-particle bombardment. This experiment was entrusted to a young physicist known as Marsden who bombarded a gold foil with alpha particles. The alpha particles are projectiles or bullets fired at the gold foil. Most of the particles go straight and are detected on the screen placed in front of the foil. They searched for the particles which are deflected and found, to their astonishment some are even deflected to the original source. Since the alpha particles were positively charged they guessed that the deflections were due to the positively charged centre. By carefully studying these deflections Rutherford determined the structure of the atom.

The picture of the atom Rutherford announced in May 1911 was that the most of the mass of the atom was concentrated in a tiny,

positively charged core, later called as nucleus, while the negatively charged electrons, with very small mass, formed a cloud around the nucleus, accounting for the size of the atom. The massive nucleus is ten thousand times smaller than the atom. Rutherford's atom was like a little solar system. But this planetary picture of the atom had to be completely unstable from the stand point of classical physics. The electron magnetic radiations and fall rapidly into the nucleus. In reality the atom was stable. This was the puzzle that plagued classical physics. Niels Bohr with the extension of the quantum concept into the structure of the atom, gave stability for the orbits and the atom.

In a Hydrogen atom, the electron in the ground state absorbs integral multiples of *h* and jumps into the higher excited orbits and fall back into the ground state after a while emitting different colours of light. Niels Bohr gave satisfactory explanation for the lights named after its discoverers like Paschen, Fund etc., ignited by these electrons when they are falling back into the ground state from the excited states. According to him, this electron makes quantum jumps absorbing discrete quantities of energy in terms of *h,* quantizing space. For the quantum mechanical description of the Hydrogen Spectra, Bohr got Nobel Prize in 1922. Thus Bohr introduced the quantization of space and linked it to the structure of the atoms.

As Einstein interpreted light as particles, Prince Victor De Broglie developed this concept into the question of why particles cannot be waves and derived the De Broglie relations, that is matter can be interchange as particle and wave. Basing on wave as the essential feature of reality, Schrodinger developed the Wave Mechanics, a mathematical structure to find the solutions for the positions of an electron in a cloud. Thus Wave Mechanics, gave a mathematical structure that is imaginative and experiential while Heisenberg introduced the Matrix Mechanics, representing the properties of physical reality of any system in a matrix and solving problems. These mathematical structures were found to be part of the same Hilbert Space where Matrix and Wave mechanics are subsets of the Hilbert Space, a mathematical space developed by the mathematicians like Max Born, Pascal Jordan, John von Neumann etc.

Interpretational Problems in Quantum Mechanics

Any state of a physical system could be represented in the Hilbert space and could be solved for solutions by manipulating either the

Wave or Matrix Mechanics, churning out results. These results are to be again related to the physical reality. Thus, interpretational principles are brought out. They are mainly, the principles of complimentarity, probability and uncertainty. Depending upon the experimental set up, you get either a wave or particle and thus according to Niels Bohr, both these complimentary natures together exhaust the reality. He extended it further to complementarities such as subject/object, man/woman, and rationality/intuition etc. The principle of probability explains that one cannot give precise statements on the determination of measurements and hence can only give probabilistic predictions only. This was proposed by Max Born who came to India and was teaching the IISc, Bangalore during the II World War. The principle of uncertainty proposes that simultaneously, one cannot precisely measure conjugate variables like position-momentum, time-energy etc. Altogether, QM proposes that what we can have is only a probabilistic prediction of the future of a reality unlike the classical physics where we can have certainties. The philosophy derived from QM is known as indeterminism proposing that there is a limit to our knowledge, controllability and predictability of reality. Also according to the proponents, a phenomenon is visible only during its measurements and it doesnot have actually an existence by itself. Moreover, the wavefunction representing the state of a system has millions of possibilities and when the measurement is made it collapses into a single value known as the collapse of the wavefunction and could not be explained in a satisfactory way. Einstein, Planck, Schrodinger, De Broglie and many other scientists could not agree with that any they brought new thought experiments in order to highlight the incompleteness of QM. However, Bohr and his associated countered by arguing that Nature is indeterministic while the other claimed that the physical theory is indeterministic. This philosophical debate is still raging on inducing to create new interpretations. One of the prominent interpretations of QM is given by David Bohm influenced by his interaction with Einstein and others. In 1981, he proposed a hidden variable interpretation, with a new mathematical structure and extending it to a multi-body system. JS Bell saw it as mathematically viable and hence many scientists are now involved in further research into the Bohmian Mechanics.

Transformation of Consciousness Through Meditation

From time immemorial, humanity reflected on the meaning of awareness and the underpinning faculties. In the Egpytian and Greek cultures, initially the heart was considered as the most important organ of the human body. Thus the Egyptians preserved the heart in cat shaped bottles while the Greeks evolved the concept of soul and linked it with awareness. In India, Hinduism, Buddhism and Jainism promoted ascetic practices in terms of Yoga-Samkhya philosophy which became later as a discipline described by Patanjali in his *Yogasutra* to control, mould and bind together, the body, mind and soul into a coherent whole. In the *Mandukya* Upanishad one can find the description of the four states of consciousness, namely, waking (jagrata) dreaming (Svapna), deep sleep (Sushupti) and Thuria which is actually the deeper back ground that underlies all the three states and transcends it. Adi Shankara in his illustrious interpretation of Mandukyakarika, relates the waking state with that of our daily world with the self identity, ego, the dreaming as the inward knowing while the third as the inner controller and knower of all experiences. In the second and the third states there are no awareness of the ego though there is awareness of the thoughts. In the dreamless sleep there is no conscious experience of internal or external objects. Verse VII of the Mandukya Upanishad describes the fourth state as the substratum of all the other three types of consciousness, throwing it into silence, *atyanta shunyata*, absolute emptiness, being one with the Brahman/ Divine, beyond the material realm[2].

> Turiya is not that which is conscious of the inner (subjective) world, nor that which is conscious of the outer (objective) world, nor that which is conscious of both, nor that which is a mass of consciousness. It is not simple consciousness nor is it unconsciousness. It is unperceived, unrelated, incomprehensible, uninferable, unthinkable and indescribable. The essence of the Consciousness manifesting as the self in the three states, It is the cessation of all phenomena; It is all peace, all bliss and non-dual.

2 *Upanishad Sarwasam*, Panditharatnam Sri K.P Narayana Pishorody (editor), Samart Publishers, Kochi, 2004. Thomas Kochumuttom, *A buddhist Doctrine of Experience. A New Translation and Interpretation of the Works of Vasubandhu the Yogacarin*, Motilal Banarsidass, New Delhi, 1999. Raju, P.T. Raju, *The Philosophical Traditions of India*, Motilal Banarsidass, New Delhi, 1992.

> This is what is known as the Fourth (Turiya). This is Atman and this has to be realized.

Thus, basing on the Upanishads and the teachings of Gaudapada and Govinda Bhagavatpada, Shankaracharya developed his Advaita philosophy interpreting the reality as spiritual and the role of the consciousness is to be merged into this Supreme Consciousness through meditation. The goal of human life and its continuous striving Shakaracharya interpreted as to search for this ultimate spiritual entity and being in union with it. Scholars claim that Shankaracharya integrated the Buddhist logical arguments in interpreting the Mandukya Upanishad and developing the illustrious Advaita philosophy. The Buddhist philosophical schools through hair splitting arguments and dialogical research have delved deep into the phenomenon of consciousness in its attempt to understand it and transform the human personality compassionate and peaceful.

According to His Holiness Dalai Lama "the Buddha said that if one trains the mind there is joy, and if the mind is undisciplined there is suffering. ..the basis that is to be purified is the mind. If it is trained, there is nirvana, or liberation, and if it is not trained, one continues in the cycle of existence knowns as samsara."[3] Buddhist schools such as Vaibhashika, Sautrantika, Yogachara, Madhyamaka classify categories and degrees of consciousness such as sensory, mental, conceptual, non-conceptual, cognition, false cognition etc its attempt to transform the consciousness. According to Dalai Lama "the mind is transformed when one ascertains and thoroughly acquaints oneself with fresh insights into the nature of reality that invalidate one's previous misconceptions or false conceptions"[4]. His Holiness also speaks the different degrees of the subtlety of consciousness such as the waking, dreaming and the dreamless as envisaged by Shankaracharya. According to Dalai Lama the subtlest form of consciousness in Vajarayana Buddhism is *clear light*[5]. His Holiness Dalai Lama summarizes the search for understanding consciousness and the major role of religions in the world as the transformation of the consciousness.

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3 Dalai Lama, "Understanding and Transforming the Mind", *Buddhism and Science*, B. Alan Wallace (editor), Columbia University Press, New York, 2003. P.93. Hereafter referred to as Understanding the Mind.

4 Understanding the Mind, p. 96.

5 Understanding the Mind, p. 97.

> I regard all the major religions, especially Buddhism, as instruments, or methods, for training the mind, for overcoming problems, primarily of the mind, specifically negative forces in our emotions, that create mental unrest, unhappiness, fear, and frustration. Such mental states result in various negative activities that bring more problems and suffering. *Dharma* means an approach for overcoming these long-term problems, so it has the connotation of protecting, or saving, one from unwanted things. Therefore, Buddhadharma is a system of transforming, or disciplining, the mind to bring about inner tranquility.

His Holiness continues to explain what is meant by this transformation of the mind. "The practice of *Dharma* involves improving the quality of one's mind, which means simply that one empowers those that are harmful to oneself".[6] So all research is to be done with the intention of the transformation of consciousness by deriving the principles that can be utilized in order to analyze the objective reality by eliminating the false cognitions and developing skillful means in pursuit of wisdom that can sustain a compassionate consciousness.

Imagination plays a vital role in this transformation process. Hence recent neuro-physiological researches conducted on Buddhist monks employing the most advanced tools such as FMRI, PET etc., measured the degree of transformation they have achieved. Matthew Ricard, a biologist turned Buddhist monk, expressed the efficacy of Buddhist meditation in achieving serenity and tranquility of mind through meditation and the transformation of his life from a scientist towards a Buddhist Monk.[7] According to Neuro Science imagination belongs to the very core of human consciousness and Buddhism claims through its centuries of experience that meditation is a means for transformation. Theravada, Mahayana, Vajrayana and Zen Buddhist traditions developed different modes of meditation to discipline, extend, renew, reconfigure and transfigure one's own consciousness and attain a stable and continuous state of compassion.[8] Great

6 Understanding the Mind, p. 99.

7 Jean Francois Revel, Matthieu Ricard, The Monk and the Philosopher: A Father and Son discuss the Meaning og Life, Schocken Books, New York, 1999. Matthieu Ricard, Xuan Thuan Trinh, The Quantum and the Lotus: A Journey to the Frontiers where Science and Buddhism Meet, Crown Publishers, New York, 2001.

8 Francisco J. Varela, Natalie Depraz, "Imagining, Embodiment, Phenomenology, and Transformation, *Buddhism and Science*, B. Alan Wallace (editor), Columbia

practioners of meditation such as Naropa and Milarepa show the ability to transform one's consciousness and how they achieved a transition from a Mahapandita towards a Mahasiddha from knowledge towards wisdom and from vengeance and hatred towards compassion. Thus, the religions, especially Buddhism tries to understand the process of knowing and the person who is knowing in its attempt to transform the consciousness and arrive at a continuous, stable and tranquil one who may be called as a person of wisdom.

Consciousness In Terms of Cognitive Science

The knowledge about the brain as the governing centre of the human body functions was not known to the early civilizations. The ancient Egyptian funerary rites that described the mummification of the body, never considered brain an important organ of the body. They mummified the heart and kept it in a special jar almost looking like a cat. However, the Edwin Smith Surgical Papyrus contains an elaborate account of twenty six different varieties of brain injuries. Alcmaeon, was of the opinion that it is the brain that controls the human body rather than the heart and was thus an exception to the general belief of his times. The Indian Ayurveda studies, especially the *Charaka Samhita* an authoritative treaty on the practice of medicine, also considered that it was the heart that governs the human body and did not give much attention to the brain. For Plato who considered everything on the earth as shadow, proposed that the human soul was bonded to the body due to sin and its perfection could only be attained by reaching the world of ideas. Aristotle, on the other hand combined the philosophical and the empirical and suggested the human body was constituted of the physical, psychical and the spiritual. He proposed that the rational soul could not be found anywhere in the body and distinguished between the long term memory and the short term memory. Herophilius and Erasistratus were capable of discovering the functions of both the brain and heart and proposed that the seat of intelligence was the brain. They also discovered the nervous system, different types of nerves and the important distinction between motor and sensory nervous systems. Galen was for almost twelve hundred years an authority on the human anatomy and discovered

University Press, New York, 2003.

the ventricles of brain as the seat of senses, emotion, memory and cognition. Andreas Vesalius, through his brain anatomical studies, discovered that human brain was similar to many of the animal brains and concluded that the sophisticated mental functions like memory and emotions are not situated in the ventricles. Descartes was the first to differentiate between the body and mind and interlinked them through the pituitary gland. Thomas Wills was the one who introduced new vocabulary to the understanding of Brain such as 'neurology,' 'hemisphere,' 'lobe,' 'pyramid,' 'corpus striatum etc. Charles Bell made the distinctions between the cranial nerve, which is connected to chewing, and the cranial nerve, which controls muscles of expression. He also demonstrated that motor and sensory functions were anatomically separated in the spinal roots. He was instrumental in discovering the functional activities of individual brain parts. This led to the search for discovering the locations of special functions like language, memory, sleep, various control systems, vision etc in the brain. Broca by studying a patient who had the capacity to understand language but failed to express it could locate the centre speech at the prefrontal cortex which is now known in his name as Broca's area.

Today, Cognitive Science, an integrated discipline with multi-disciplinary approach comprising a number of disciplines such as Neurophysiology, Computer Science, Artificial Intelligence, Philosophy of Mind, Linguistic Philosophy, Sociology, Psychology and many others together to investigate phenomena such as cognition - the processing of thought, learning, language perception, memory, dream, speech, behaviour co-ordination, reflex actions, imagination, creativity etc. Cognitive Science come up with many different theories ranging between dualism and monism such as brain as the hardware while mind as the software, mind as epiphenomenon like magnetism, cognitivism claiming a causal efficacy between brain states and mental states, physicalism and eliminative materialism rejecting any mental phenomena and reducing everything into brain states into Brain-Mind identity theories etc. Neurosemiotics deals with the structure of the brain while Neurosemantics describe the processing of thought and other functions of the brain in terms of crunching symbols.

Recent research revealed that the brain is an organized structure, divided into many parts that perform specific and important

functions. The brain consist more than 100 billion neurons that link up with each other and all the nervous in the human body. Normally the brain weighs about 1.4 kg. The whole work of the brain is not fully understood. However, each part of it has different functions. The brain and spinal cord contains two main types of tissues: Gray matter, which originates and processes nerve impulses; and White matter, which transmits them. Brain is protected by a shell called skull. The largest structure in the brain is the *Cerebrum,* and is divided into two halves.

The brain can be divided generally into three regions, *the cerebrum,* which controls our thoughts, *the cerebellum* and *brain stem,* which controls the vital functions of the body like breathing, heart rate etc. The central region of the brain also includes the thalamus, and hypothalamus. The spinal cord is an extension of the brain stem and continues downward from the base of the skull. The neuron is the basic cell of the nervous system, a microscopically small cell that transmits information in the form of impulses from one part of the body to another. Neurons were discovered at the beginning of the 20th century. There are an estimated 100 billion cells in the human brain.[9]

> *The brain is composed primarily of neurons (routes) and each neuron creates connections with other neurons, convey signals through these connections and is modified as a result of the transferred signals. The functional atoms of the brain are cells called neurons. These have a natural or default level of activation that can, however, be modulated up or down by external influences. From each neuron, there extends a long, thin out put fibber called axon. It branches out and get connected with or rather make synaptic connections with either the central cell body or the bushy dendrites of other neurons. In this way, each neuron receives inputs from a great many other neurons.*

Since neurons are the basis from which all the system of concepts stems; it should also serve as the basis or building blocks for explaining them. The complexity of the outcomes (concepts and mental states) is due to the quantity and the complexity of the routes and connections. As all concepts are manifestations of interactions between neurons, their nature remains simple and straightforward. For example, as a sentence is formed through connecting between words and an explanation through connecting between concepts,

9 Churchland, *"Cognitive Activity in Artificial Neural Networks*." 198.

in this way connecting is the essence of the neurons' activity. This correlation is by no means incidental since the neurons are what create the words, the concepts and the connections between them.

Neurons show wide variations in size and in infinite variety in the arrangements of their processes. There are three types of basic neurons in our nervous system: sensory neurons, motor neurons, and inter-neurons. Each performs a different function. Most of them have a few structures in common. The first structure they have in common is the cell body, which is the largest mass of the neuron. It contains the nucleus of the cell in which the genetic information is located. This information keeps the cell functioning. Protruding from the cell are several tentacle-like structures called dendrites and a particularly long structure called the axon. The dendrites reach out to receive impulses from nearby neurons. These impulses are sent to the cell body down the axon to other neurons, muscles, or glands. Some axons are quite long - as much as two or three feet in the spinal cord. There is both electrical and chemical signalling between the neurons. And these play a vital role in the communications between the neurons. Electrical synapses are of two types: one is field potentials, in which sending and receiving neurons are so closely positioned and current flow in one induces field change in it neighbour. And the other is gap junctions. It consists of supremely thin protein tubes connecting the axon of one neuron to the dendrites of another. The tubes are so narrow as to permit the transfer of only very small ions such as Na^+ or K^+, it is through this ions the signals are transmitted from one neurons to another.

In chemical synapses it is Ca^{++} ions and Ca^{++} channels play the vital roles. When a depolarizing wave reaches an end bulb of an axon, it opens voltage sensitive Ca^{++} channels. Ca^{++} rushes into the cell and causes little vesicles containing neurotransmitters substance to fuse with the outer membrane at specialized zones. As the vesicles membrane fuses with the cell membrane, the neurotransmitter substance is released into the extra cellular space that separates the axon from the adjacent neuronal processes.[10] Each neuron is composed of one or two axon which work as output and many dendrites which work as input of electrical signals. Neurons need certain strength of signal input that adds up from all the dendrites to be triggered. Once triggered, the neuron will fire and send an

10 Churchland, *Neurophilosophy: Toward a Unified Science of the Mind/ Brain*, 62.

electrical signal down its axon to other neurons. Connections (axon and dendrites) will strengthen if they are often used.

Neurons are organized in layers.[11] The input layer will have entries, and depending on the strength of connection to each neuron in the next layer, the input signal is sent to the next layer. The strength of the connection is called a weight.[12] The value of each neuron in each layer will depend on the weight of the connection and the values of the neurons of the previous layer.[13] There are importantly two type of neural networking as parallel and serial. In the serial mode of networking, the neurons relate to each other in a way that is one after another. This mode affects making choice in an efficient way and it is very slow in working. This was the type which persisted in the computer on its very beginning. And in these days the computer engineers are trying to have parallel mode of networking which is in a way a real mimic of the structure of the brain.

As opposite to the serial neural networking in the parallel neural network, the neurons relate to each other simultaneously at the same time. "Sequential and parallel learning techniques for codebook design in vector quantizers using neural network approaches. These techniques are used in the training phase of the vector quantizer design."[14] These learning techniques combine the split-and-cluster methodology of the traditional vector quantizer design with neural learning, and lead to better quantizer design (with fewer distortions).

> *The sequential learning approach overcomes the code word underutilization problem of the competitive learning network. As a result, this network only requires partial or zero updating, as opposed to full neighbour updating as needed in the self organizing*

11 Most neural networks have three groupings of software: input, output, and a layer in between. The input neurons represent the raw information that is fed into the network. The out put neurons represent the resulting behaviour. The middle layer gives great flexibility in representing the relation between the inputs and the outputs. (alien)

12 Learning in neural networks involves adjusting the weight associated with the links between the software neurons. These weights store the knowledge necessary to solve specific problems. Neural networks use feedbacks to adjust the weights. Signals from the output neurons are fed back so that they become the inputs to the middle –layer neurons.

13 Martin, *After the internet: Alien intelligence*, 337.

14 Churchland, *Neurophilosophy: Toward a Unified Science of The Mind/ Brain*, 425.

feature map. The parallel learning network, while satisfying the above characteristics, also leads to parallel learning of the code words. The parallel learning technique can be used for faster codebook design in a multiprocessor environment.[15]

Computer scientists call parallel processing as "the simultaneous application to a single task of many processors, be they neurons or computers."[16] The brain uses parallelism to run different processes simultaneously. Similarly a supercomputer can also use parallelism to run similar processes many times simultaneously. Thus in short the parallel networking of brain is much well used in computers. Today the artificial intelligence researchers are of the view that, once we are able to duplicate the functions of the neurons, through the parallel neural networking, it may be possible to create an artificial intelligent machine. In short the artificial neural networks are composed of interconnected units like neurons in the brain. Each software neuron receives a collection of incoming signal and converts these inputs into a single outgoing signal. A modifiable *weight* is associated with each connection that enters the neurons.[17] Each incoming signal is multiplied by the weight on the connection and the signals are combined together to produce an output signal. The output travels over connections to other neurons, just as in the brain. Basing on the neuronal structure, cognitive behavior is described in terms of Neurocomputational perspective by the Churchlands in their attempt to reduce the mental phenomena into brain states and ultimately as a material phenomena.

Neuro-computational Network Theory

There are a great deal of arguments that came forth with regard the functions of the brain, some are of the view that the neurons of the brain are the hardware of the computers and what we need to do is to just find out its software. An enormous amount of knowledge is gathered about the structure of nervous systems. What is not understood is how nervous systems function. The understanding about the neuron, - its membrane properties, the spiking properties of its axon, the synaptic phenomenology, its patterns of connectivity, the transport of intracellular materials, its

15 Hall, "*Neurons*," [Online].
16 Crevier, *Artificial Intelligence: The Tumultuous History of The Search for Artificial Intelligence,* 301.
17 Martin, *After the internet: Alien intelligence*, 323.

metabolism, and even something of its embryological migration and development are still in the initial stages. These new theories are proposed to understand the brain functioning and if found explicable the intelligent behaviour, then this methodology can be applied to further developments of artificial intelligence.

A tensor is a generalized mathematical function for transforming vectors[18] into other vectors, irrespective of the differences in metric and dimension of the coordinate systems.[19] Vectors are represented geometrically as directed line segments in a specified coordinate system (frame of reference). If each neurons in a network of inputs neurons specifies an axis of a coordinate system, then the input of an individual neuron defines a point on the axis, and the input of the whole array of neurons can then be very neatly given as a vector in that space. Similarly, the output of an array can be specified as a vector in the space defined by the set of output neurons.[20] The idea that the tensor network approach really provides gives a theoretical framework within which questions about brain function can be addressed and answered. The theory put forward the idea of parallel connections in the brain. In sum tensor theory can be defined as follows: [21]

> *The tensor network hypothesis says that a neural network implements its general function as a connectivity matrix to transform inputs vectors into output vectors. There are, accordingly, two important stands in the hypothesis. The first accommodates the fact that the coordinate systems (parallel) of neuronal ensembles will specify different frames of references but must be systematically related, and the second accommodates the parallel nature of neuronal networks, by proposing that individual neurons in the array contribute the components to the vectors, while the structure the connectively between neuronal arrays determines the tensorial matrix. It is by trying to do justice to the parallel nature of nervous systems that one comes to fathom how they could use tonsorial transformations to achieve sensorimotor control.*

The computational theory of mind is presented intentionality within a framework of natural science. Paul and Patricia Churchlands together developed this concept and the most advanced form of

18 Quantity that has both magnitude and direction, (mathematics), an organism transmits a particular diseases or infection. (Oxford Dictionary).

19 Churchland, *Neurophilosophy: Toward a Unified Science of the Mind/ Brain*, 418.

20 Churchland, *Neurophilosophy: Toward a Unified Science of the Mind/ Brain*, 417.

21 Churchland, *Neurophilosophy: Toward a Unified Science of the Mind/ Brain*, 433.

brain functioning through their Neuro-computational net work theory. Paul and Patricia are philosophers of what used to be known as the "eliminative materialists". The objective was to eliminate our everyday view of the mind in terms of the propositional attitude in favour of a new, scientific one based on vector computation and neural networking where there is no more the usual mind/body problem. To say it in nutshell, it's the difficulty we all seem to have in seeing how mental states - feelings, thoughts, indeed any form of experience - can be physical, or even objectively explicable. It is fashionable these days to blame this problem on Descartes, but the much more ancient pedigree of religion and belief in the immaterial soul hint that the problem may be more deeply rooted than anything planted in our minds in the seventeenth century.

Churchland makes no secret of his strategy to eliminate it: "I hope to make available here a conceptual framework of sufficient richness and integrity [so] that you will be able to re-conceive at least some of your own mental life in explicitly neuro-computational terms"[22] And so he does, surveying a good bit of contemporary cognitive neuroscience, including brain and behavioural modelling (to which he himself has made some original computational contributions, putting into practice his principle that philosophical problems can be solved by assimilating them to science).

"Neural nets" is the new technical concept introduced by Churchland. The term is ambiguous, because there are, on the one hand, undeniable networks of neurons in the brain, but there are also networks of artificial or notional "neurons" that are implemented on computers. Worse still, the nets implemented on computers are usually discrete, serial simulations of what are intended to be continuous, parallel, distributed systems. Churchland is betting on the first and the third of these, indeed he is taking them to be one and the same thing; but he is an explicit critic of purely computational models of the mind, in that respect making common cause with other critics of computation such as the philosopher John Searle and the mathematician Roger Penrose, though he is at pains to dissociate his own arguments from theirs, which he finds wanting.

Churchland proposes the notion of "vector activations" by surveying the sensory physiology of taste, colour and smell. Each

22 Harnad, "Thoughts as Activation Vectors in Recurrent Nets, or Concentric Epicentres, or...," [Online].

of these senses has detectors, with complex sensations involving the activity of combinations of them. Colour is a familiar example. Among the cones in the retina there are some areas that are selectively activated by red, others by green, and still others by blue. Leaving out a few complicating details, it can be said that linear combinations of the activation levels of each of those three detectors will generate all the colours we are capable of seeing. It accordingly seems correct to describe colour space vectorially as a sensory activation space.

As a similar story can be told about the other senses, it seems reasonable to think of all sensory input as vector activations of some kind. Indeed, since, to a human, all "input" is sensory input, vector activation sounds like a very general notion indeed. Basing on this fact, Churchland moves a level higher than raw sensory processing to the more complex case of face recognition. In doing so he also takes leave of brain and behavioural evidence and passes to computational evidence: Like ourselves, artificial neural nets turn out to be able to classify faces (both facial expressions and facial identities), and they do it by partitioning vector activation space. Neural nets consist of layers: the input layer is the sensory input vector; the output layer is the motor activation vector; and various hidden layers in between are internal vectors, their components interconnected with the input and output vectors. The net accomplishes what it does by adjusting the strength of its interconnections, and hence the strength of the input, hidden, and output vector activations, on the basis of various kinds of built-in learning rules.

Quantum Consciousness Models

The Penrose-Hameroff Model.

Roger Penrose is a mathematician and physicist who had worked along with Stephan Hawking. Stuart Hameroff is an anesthesiologist, medical professional who was interested in the research on consciousness.[23] While he was a medical student, he did experiments on cancer related issues and found the role microtubules played in cell division. He speculated that some ways of computing controlled the cell division which he extended

23 http://www.quantumconsciousness.org/penrose-hameroff/quantumcomputation.html

towards the analysis of consciousness and published in 1987 as a book with the title *The Ultimate Computing*.[24] Hameroff established the first **Tucson Toward a Science of Consciousness Conference** in 1994 along with Penrose and many other leading theorists on consciousness and formed the Association for the Scientific Study of Consciousness. Penrose also on the other hand interested in the research on consciousness and considered it as a non-linear problem. Basing on the Goedel's Incompleteness Theorem - that no logarithm could prove anything since what is to be proved is incorporated already in the theorem as presupposition- Penrose argued that brain could function better than any computer and hence consciousness might be non-algorithmic against the prevalent thought of scientists in the field of robotics and artificial intelligence. Penrose elaborated these thoughts in his book on *The Emperor's New Mind*.[25] Penrose observed that the principles of quantum mechanics could provide an alternative non-algorithmic processes that could describe the functions of consciousness which he termed as Objective Reduction (OR). He proposed that the OR could definitely connect with the spacetime geometry described in the theory of relativity. Hameroff was fascinated by the proposal of Penrose and introduced his microtubules would be a good candidate for a quantum mechanism in the brain. The two collaborated together to present the Orchestrated Objective Reduction Orch-OR model of the functioning of consciousness which is published as *The Shadows of the Mind*.[26] Penrose and Hameroff was severly criticized by the Neuro-philosopher Churchland physicist Tegmark etc. However in 2014 January, quantum vibrations are discovered in microtubules by Anirban Bandyoupadhyay of the National Institute for Materials Sciences in Japan confirming the Orch-OR theory giving credence to the Penrose-Hameroff model.[27]

Bohm's Quantum Potential Model

24 Stuart Hameroff, *Ultimate Computing,* Elsevier, 1987.

25 Roger Penrose, *The Emperor's New Mind,* Oxford University Press, Oxford*, 1989.*

26Stuart Hameroff and Roger Penrose. Consciousness in the universe: A review of the 'Orch OR' theory. *Physics of Life Review*s, 2013 DOI:10.1016/j.plrev.2013.08.002

27http://www.sciencedaily.com/releases/2014/01/140116085105.htm. Discovery of quantum vibrations in 'microtubules' inside brain neurons supports controversial theory of consciousness

Influenced by Einstein and being convinced of the inherent conceptual dichotomies of Quantum Mechanics as interpreted by the Copenhagen physicists led by Niels Bohr, David Bohm in 1952 proposed that a quantum potential guides the particle and gave sufficiently mathematical presentation of a hidden variable interpretation of quantum mechanics.[28] According to him, the quantum potential is a mathematical devise in classical physics while in the quantum phenomena it has a definite existence. This alternative interpretation was rejected by the scientific community as Bohm was proclaimed to be a Marxist sympathizer and revoked his American passport and banished from the country. He continued his research with Basil Hiley of the Birkbeck University London and extended the proposal to three particle system and to further quantum field theories using Clifford Algebra. J.S Bell who saw this alternative interpretation of QM by Bohm and the denial of any such interpretation by von Neumann through the impossibility theorem, proved logically that both of them are not in contradiction. Bohm's interpretation is a non-local one while von Neumann's theorem prohibited only the local interpretations. The Obuchi Okata discovery of a single photon creating an interference pattern showed the remarkable predictability of the Bohmian interpretation and many scientists were attracted towards his interpretation. New research is being conducted on the Bohmian Mechanics and it attracts the scientists because of its capability of providing conceptual clarity in many of the quantum realms and is founded on the deterministic framework. Thus it has the rare distinction of bringing together the classical physics, theory of relativity and quantum mechanics under a single philosophical foundation.

The Bohmian Mechanics or quantum interpretation could very well provide a possible guidance to the integration of the consciousness with the quantum processes. It can further extend it towards how the spirit guides the matter like the information in the seed is forming into a particular plant as the quantum potential guides the particle. Quantum potential is the information and the particle follows a particular trajectory as the information stored in the seed governs it to grow into a particular plant or tree though

28 Mathew Chandrankunnel, *Quantum Holism to Cosmic Holism: The Physics and Philosophy of David Bohm*, Global Vision Publishing, New Delhi, 2008.

the same, water, manure, sunlight is processed by different plants. So as the quantum potential as information guides the particle, the spirit can guide matter. Similarly the consciousness can guide the body to realize its own aspirations.

Conclusion

Though there are conceptual ambiguities in both Quantum Mechanics and Consciousness, if both could be integrated it may be the best possible theory to explain better the dynamics of consciousness. However, research has to be conducted further in discovering the domains where the possible interaction of the consciousness would be enacted since the quantum domain remain in the 10^{-13} domain and we are not sure about the domain of consciousness. However, the irony is that the application of the quantum mechanics would ultimately reduce the consciousness into a mere physical phenomenon. Dream, creativity, knowing, sleep, all would be reduced to either as a networking of parallel processes following some physical laws or algorithm as described by the Neuro-computational perspective. However, it seems that ultimately all theories must lead to transformation or practical applications. QM could not give conceptual clarifications, denies any meaningful questions, but it works, as a pragmatic philosophy; Consciousness doesn't have any influential theory that can describe and understand its complex functions. QM could give some meaningful explanations if it is applied to consciousness. However, since both are ambiguous, conceptual clarity and verification could be very difficult to be arrived at. So what is important is to develop tools of transformation as the Buddhist theorists would have done in the past that could change individual and societal inertia as done by the great masters all over the world. All the theories, methods and models try to understand the complexities of the consciousness so that tools of transformation could be achieved. In India, these types of spiritual, meditational and philosophical attempts were done from the very beginning of thought and now it is high time that we should also incorporate the scientific disciplines such as Quantum Mechanics, Neurology, Neuro-technology, Psychology, Information Technology, artificial intelligence etc to understand the dynamics of consciousness from an interdisciplinary approach and to develop tools of transformation to higher dimensions and states of consciousness. Such researches were very common in Europe

and Unites States and this is a rare opportunity for us to discuss and understand the phenomena of consciousness from multi-dimensions and perspectives. Theses understanding may help us to develop tools and process of transformation of the individual and the society that may help to further our understanding of the matter and spirit, of QM and Consciousness in the near future.