A new look at the Heisenberg's uncertainty principle

A cybernetics and general dynamical systems approach

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Abstract

Purpose – To develop a mathematical and algorithmic approach of avoiding the limitations of deterministically computing the values of energy, time, position and momentum imposed by Heisenberg's uncertainity principle (HUP) which is of profound significance from the point of view of some emerging science and technology like quantum computing, nano scale technology and chaotic dynamical systems.

Design/methodology/approach – A parametric method of establishing deterministic solutions for energy and momentum on the basis of quantized energy limits (instead of HUP) if developed in the non-infinite non-zero quantized energy limits where hidden deterministic solutions can be obtained for micro/nano structures.

Findings – The philosophical foundations of quantum mechanics as developed by Max Planck, Neils Bohrz, Werner Heisenburg, Dirac and Edwein Schrodinger is based on a duality concept of complimentarity notions. In most general logical sense for any physical reality qualitative dualism have to have a quantitative dualism may be hidden or virtual. The upper and lower limits of the dynamical quantum mechanical observables are determined based on the dimensional considerations for the physical constants H, C, G and H_0. The conceptual basis and mathematical framework of the paper in based Norbert Wiener's work on theory of cybernetics and D. Dutta Majumdars' unified cybernetic and general dynamical systems theory.

Research limitations/implications – The testability of the theory needs to be established.

Originality/value – Without challenging HUP this is a contribution of tremendous practical implications.

Keywords Cybernetics, Uncertainity management, Nanotechnology, Systems theory

Paper type Research paper

1. Introduction

Heisenberg's uncertainity principle (HUP), a fundamental concept of quantum physics, indicates to ability of an experimenter or that control system (automation) to measure an elementary particle's position to the highest degree of accuracy, leading to an increasing uncertainity in being able to measure the particle's momentum to an equally high degree of accuracy. This implies that the uncertainity in the value of the energy is significant in extremely small time elements. HUP is mathematically expressed in any of the following forms:

$$\Delta E \cdot \Delta t \geq \frac{h}{4\pi}, \quad \Delta x \cdot \Delta p \geq \frac{h}{4\pi} \tag{1}$$

The *uncertainties* in energy, time, position and momentum are ΔE, Δt, Δx and Δp and h is Planck's constant (where $(h/4\pi) = 0.527 \times 10^{-34}$ Joule-second).

This energy uncertainity in extremely small amount of time is of profound significance from the point of view of several emerging science and technology, such as chaotic dynamical systems (Barone *et al.*, 1993; Raymer, 1994; Hall and Regina Ho, 2002), nano science and technology (Raymer, 1994; Drexier, 1992; Koller and Athas, 1992; Technical Proceedings, 2003), and quantum composing (Collins, 2006) among others. It is stated that in classically chaotic systems, irreducible uncertainties required by the Heisenberg's principle are amplified exponentially some time to macroscopic level in very short times (Barone *et al.*, 1993). In this situation the behavior of the system is unpredictable in the sense that it is not practical to include all perturbations, which have a significant effect on the behavior of the system. This apart from other things brings the uncertainity principle into the realm of classical mechanics. We may also remember that HUP involved the perturbation to a particles' state by a measurement of one variable, which affects one's ability to predict the outcome of a subsequent measurement of the conjugate variable, which is not just some form of measurement error but concerns physical variables intrinsic to a particle's state. For example, at a precise time, t, the energy of an electron is not determinable to a precision greater that $(h/4\pi)$ because the energy of the electron physically varies by this amount within a Planck like time parameter. This means electrons' energy fluctuates in this narrow range – which might suggest a violation of the conservation of energy.

To avoid these and several other limitations of indeterminacy relations, we use the frame work by Dutta Majumder (Dutta Majumdar, 1979; Dutta Majumdar and Majumdar, 2004a, b; Dutta Majumder and Bhattacharya, 2000) in which observer, observed, and act of observing are combined in a unified general dynamical systems framework consisting of machines, human being and relevant environment, with the legitimate assumption that these observations and interactions are cybernetic process which is an extension of the formalism enunciated by Norbert Weiner in his celebrated work in 1944 (Heisenberg, 1930). In this framework we develop a computationally realizable deterministic solution to quantum measurement problems in the non-infinite non-zero quantized energy as in Dutta (1995).

1.1 Perspective

A problem of fundamental importance in nature, man, society and machines in developing a general dynamical theory of physical systems and also that of cybernetic systems are the unifying concept of state space and system causality (Dutta Majumdar, 1979; Dutta Majumdar and Majumdar, 2004a). In an n-dimensional state space there are n independent attributes and may be denoted by X_n. The time evolution law is a continuous function f: $X_n \times T(X_n$, where T is the space of time. A dynamical system is formally denoted by (X_n, f) or just by f, when there is no confusion about the state space X_n.

To determine any physical dynamical system (X_n, f) it is essential to be able to measure each input state and each output state. In other words, we must be able to measure each point in the state space X_n. The time evolution law is a continuous function Dutta Majumdar and Majumdar (2004a):

$$f : X_n \times T \rightarrow X_n \tag{2a}$$

Here T is the space of time. A dynamical system is formally denoted by (X_n, f) or just by f, when there is no confusion about the state space X_n. The concept of state has long played an important role in physical sciences. It was *H.* Poincare who attempted to give a more precise formulation to the concept of state, and subsequent works by Birkoff (1977), Kalman (1962) Markov (1931) as elaborated in Dutta Majumdar and Majumdar (2004a). To determine the system in any (X_n, f) it is essential to be able to measure each input state and each output state. In other words, we must be able to measure each point in the state space X_n. By HUP Heisenberg (1930) (Werner Heisenberg 1930, 1949) for any dynamical system, we have as in equation (1).

$$\Delta x \Delta t \geq \frac{h}{2\pi} \tag{2b}$$

Here Δx is the error in measuring $x \in X_1$ (assuming the state space to be one-dimensional for simplicity), Δt is the error in measuring t, and h is Planck's constant. The uncertainity principle, the doctrine that inspired Albert Einstein's remark that he could not believe that God played dice with universe, was announced in 1927 (Heisenberg, 1930; Roy and Dutta Majumdar, 1996 and Roy *et al.*, 1996).

According to equation (2b) if we want to make $\Delta x \rightarrow 0$, we get $\Delta t \rightarrow \alpha$. If we want to locate the position of point in X_1 by a computer or automation it will take infinite time. So from the point of view of real-life situation of computability, algorithm city and complexity analysis (Dutta Majumdar and Majumdar, 2004a; Heisenberg, 1930; Roy and Dutta Majumdar, 1996) and also from the point of nano-science and classical physics it seemed to be the limiting case of visualization of a fundamentally unvisualisable microphysics, or micro-nanophysics. The more accurate realization attempt is made the more Planck's constant vanishes relative to the parameters of the system. One of the authors (Dutta Majumdar, 1979) in his Norbert Wiener Award Paper formulated that:

> The method of special theoretical systems and empirical testing breaks down at two points. One is at the point of Heisenberg's principle of indeterminacy, where the information that the investigator, endeavourer to extract from the system has the same order of magnitude as the system itself. Though the principle was first noted in physical systems, it is equally important in biological and social systems at different levels of observations.

This was also the cause that lead Zadeh' (1973) principle of incompatibility uncertainty management in man-machine-nature systems in different scales of the evolving information systems (Dutta Majumdar and Majumdar, 2004a; Heisenberg, 1930; Roy and Dutta Majumdar, 1996; Roy *et al.*, 1996; Zadeh, 1973; Pal and Dutta Majumdar, 1986). The existential truth in decision making and uncertainty minimization/elimination problem in real-life design problems in computational mathematics, information technology components and system design, and non-numerical information processing like pattern recognition, speech/image analysis, computer vision, intelligent systems and their hardware/software implementation and in emerging micro/nano technology development is of profound implications (Dutta Majumdar *et al.*, 2006; Pal and Bezodek, 1994; Dutta Majumder and Das, 1980; Pal and Mitra, 2001).

It may be noted that all previous investigation on complexity analysis and uncertainty management for decision-making purposes in science/society and engineering (Dutta Majumdar and Majumdar, 2004a; Heisenberg, 1930; Dutta Majumdar, 1993; Pal and Dutta Majumdar, 1986) using diverse types of soft computing approaches including Fuzzy, ANN Neuro-Fuzzy, etc. (Zadeh, 1973; Pal and Dutta Majumdar, 1986; Pal and Bezodek, 1994; Dutta Majumder and Das, 1980; Pal and Mitra, 2001) or otherwise in the unitary discipline of cybernetics and general systems theory was a conceptual reality under the limitations of HUP (Dutta Majumdar, 1979).

In this paper, we present a somewhat different non-conventional method of establishing a virtual or hidden, but computationally realizable deterministic solutions to quantum measurement problems in the non Infinite non zero quantized energy limits (Dutta, 1995), to avoid limitations of HUP in real life design problems in nano or nano-micro regions.

In this method the Planckian wavelength is used as the lower cutoff, while the upper cutoff is calculated using Yukawa – de Broglie graviton hypothesis and some cosmological assumptions concerned with the big bang theory and Einstein's field equation and a general equation for quantized energy (E_g) of the graviton (Roychowdhury, 1979; Dutta, 1995).

Neither the new approach nor its generalization by Dutta Majumdar (1979) in his Unified theory of cybernetics and general dynamical systems is in contradiction of HUP (Heisenberg, 1930), rather, it provides a deeper understanding, interpretation and a wider implication of the issues involved in formulating a computationally realizable deterministic solutions in the quantum mechanical framework.

2. The algorithm for the non-infinite non-zero quantized energy limits of upper and lower cutoffs

Max Planck in 1899 Dirac (1932) calculated his quantities λ_p (Planck length), τ_p (Planck time), E_p (Planck energy) based on the dimensional considerations of the physical constants h (Plancks' quantum constant), c (the velocity of light in vacuum) and G (Newton's gravitational constant). Similarly, in the present case the deterministic parameters ($E, \vec{p}, \vec{x}$ and t) are obscure from direct observation. It is shown here that they are (nevertheless) mathematically determinable as functions of uncertainity, $E = f(\Delta E)$ and $p = f(\Delta p)$. In the measurement process, an observer gets $\{E \pm (\Delta E)\}$ and $\{p \pm (\Delta p)\}$ as the observed values of the energy (E) and momentum (p) of a particle. A dynamical variable in uncertainity relations after imposing the non-zero and non-infinite quantization limits of $E, \vec{P}, \vec{\lambda}$ and τ become as in Figures 1 and 2.

Here h is Planck's quantum of action; c is velocity of light; G is Newtons gravitational constant, and H_0 is Hubble's cosmological constant.

All the above mentioned constants and the terms given in Figures 1 and 2, serve as the absolute limits of the micro and macro dimensional scale for an observer, in a physically perceptible universe. It needs to be mentioned that the values of E_p, τ_p, p_{max} and λ_{max} were calculated by Max Planck from pure dimensional

E_p (Planck's Energy) = $\left[\frac{hc^5}{\theta}\right]^{\frac{1}{2}}$ {Dimensionally, the maximum quantized, energy]	E_{min} (Rest energy of photon) = $\left[\frac{hH_0}{2}\right]$ [Dimensionally, the minimum non-zero quantized, energy]
$\tau_p = \left[\frac{hg}{c^5}\right]^{\frac{1}{2}}$ = (Plancks' time) [Dimensionally, the minimum non-zero time interval]	$\tau_{max} = (2H_0^{-1})$ (Maximum non-infinite time interval)

Figure 1.
Energy – time

$p_{max} = \left[\frac{hc^3}{G}\right]^{\frac{1}{2}}$ [Maximum quantized momentum λ_p]	$p_{min} = \left[\frac{hH_0}{2C}\right]$ [Minimum non-zero momentum]
(Plancks' length) = $\left[\frac{hG}{c^3}\right]^2$ [Minimum, non-zero segment of length]	$\lambda_{max} = \left(2H_0^{-1}c\right)$

Figure 2.
Momentum – wave length

consideration of the universal constants, h, c and G (Planck, 1899; Dirac, 1932). The other values of $E_{\min}$, $\tau_{\max}$, $p_{\min}$ and $\lambda_{\max}$ are variables of the macro time scale $(2H_0^{-1})$ and length scale $(2H_0^{-1}c)$ of our finite universe.

H_0 being the Hubble's parameter, a time interval greater than H_0^{-1}, is not dimensionally conceivable, and so a light signal cannot travel a distance greater than cH_0^{-1}, which is Hubble length and is considered as the radius of the observable universe. So $2cH_0^{-1}$ is considered as the diameter of the universe, and so is the maximum wavelength $(\lambda_{\max})$ that correspond to the minimum non-zero quantized energy $(E_{\min})$. so:

$$\left.\begin{aligned} \lambda_{\max} &= 2CH_0^{-1} \\ \tau_{\max} &= 2h_0^{-1} \\ E_{\min} &= h\frac{H_0}{2} \end{aligned}\right] \tag{3a}$$

The expressions (3) are valid for a particular instant of time t_0 when $H = H(t_0)$. H_0 is considered as constant for all practical quantum measurements.

2.1 The energy – time uncertainty relations

The energy – time uncertainity relations, $[\Delta E \Delta T \geq (h/2)$ in the extreme limiting cases by relating with the Bohr's complimentary principle (Heisenberg, 1986a, b; Born, 1986) on the basis of dimensional equivalence can be presented as follows:

$$(\Delta T)_{\min} = \tau_{\mathrm{p}}$$

so:

$$(\Delta E)_{\max} = \frac{E_p}{4\pi} \quad \left(\because E_p = \frac{h}{\tau_p}\right)$$

$$\because (\Delta E)_{\max} (\Delta T)_{\min} = \frac{h}{4\pi} \tag{3b}$$

$$\because \left(\therefore \hbar = \frac{h}{\tau_p}\right)$$

Dividing both sides of equations (3b) by $(\Delta T)^2_{\min}$, we get:

$$\frac{(\Delta E)_{\max}}{(\Delta T)_{\min}} = \frac{h}{4\pi(\Delta T)^2_{\min}} = \frac{h}{[\sqrt{4\pi}(\Delta T)_{\min}]} \frac{1}{[\sqrt{4\pi}(\Delta T)_{\min}]}$$

or:

$$\frac{(\Delta E)_{\max}}{(\Delta T)_{\min}} = \frac{h}{(\sqrt{4\pi}\tau_p)} = \frac{(E_p/\sqrt{4\pi})}{\sqrt{4\pi}\tau_p} \tag{4}$$

Similarly, by substituting:

$$(\Delta E)_{\min} = E_{\min} = \left(\frac{hH_0}{2}\right)$$

We get:

$$\frac{(\Delta E)_{\min}}{(\Delta T)_{\max}} = \frac{\sqrt{4\pi}E_{\min}}{(\tau_{\max}/\sqrt{4\pi})} = \frac{\sqrt{4\pi}(hH_0/2)}{(2H_0^{-1}/\sqrt{4\pi})} \tag{5}$$

From equation (1), we can write:

$$\frac{E_p}{\sqrt{4\pi}} = \{E_p^{1/2}(\Delta E)^{1/2}_{\max}\} \tag{6}$$

Also, from equation (5), we can write:

$$\sqrt{4\pi}E_{\min} = \left\{\sqrt{4\pi}E_{\min}(\Delta E)\frac{1}{2}\right\} \tag{7}$$

The required maximum and minimum cut off limits, which were determined dimensionally, are modified as $(E_{\mathrm{p}}/\sqrt{4\pi})$ and $(\sqrt{4\pi}E_{\min})$, respectively, by taking the uncertainity relations into account.

The geometric mean of E_p and E_{min} is written as:

$$\in = [E_p E_{min}]^{1/2} \tag{8}$$

From equations (4), (5) and (6) a generalized equation for E as a function of (ΔE) is:

$$E = \{E_p^{1/2} + \sqrt{4\pi} E_{min}^{1/2}\}(\Delta E)^{1/2} - \in_0 \tag{9a}$$

The equation (9a) satisfies all possible values of quantized Energy E ranging from $\sqrt{4\pi} E_{min}$ to $E_p/\sqrt{4\pi}$ for values of (ΔE) ranging from $(\Delta E)_{min} = (E_p/4\pi)$.

Subsisting the values of the constants in equations (9a) the energy equation becomes:

$$E = \left[2\pi\left(\frac{he^5}{G}\right)^{1/2}(\Delta E)\right]^{1/2} + \left[4\pi\left(\frac{hH}{2}\right)(\Delta E)\right]^{1/2}\left[2\pi\left(\frac{hc^5}{G}\right)^{1/2}\frac{hH_0}{2}\right]^{1/2} \tag{9b}$$

This is deterministic equation of E in terms of ΔE and some universal constants.

It may be noted that from the computational point of view the equation (9a) and (9b) are deterministic equation of E in terms of ΔE and some universal constants, and is a quadratic equation with two roots, one positive and other negative in conformity with behaviour of quantum relativistic particles.

2.2 Position – momentum uncertainty relations

The momentum p of a particle has three components p_x, p_y and p_z in the directions of the three co-ordinate axes, and say the position of the particle in space is (x, y and z).

Then $p = \sqrt{p_x^2 + p_y^2 + p_z^2}$ and the uncertainity relations for components of p are:

$$(\Delta p_x)(\Delta x) = \frac{h}{2}(\Delta p_y)(\Delta y) \geq \frac{h}{2} \quad \text{and} \quad (\Delta p_z)(\Delta z) \geq \frac{h}{2} \tag{10}$$

Applying similar methods, equations of the form:

$$p_x = f(\Delta p_x); \;\; p_y = f(\Delta p_y) \quad \text{and} \quad p_z = f(\Delta p_z) \tag{11}$$

are given below:

$$p_x = \left\{\left(\frac{E_p}{c}\right)(\Delta p_x)^{1/2}\right\} + \left\{\left(\frac{4\pi E_{min}}{c}\right)((\Delta p_x)^{1/2})\right\} - \left(\frac{\in_0}{c}\right)$$

$$p_y = \left\{\left(\frac{E_p}{c}\right)(\Delta p_y)^{1/2}\right\} + \left\{\left(\frac{4\pi E_{min}}{c}\right)((\Delta p_y)^{1/2})\right\} - \left(\frac{\in_0}{c}\right) \tag{12a}$$

and

$$p_z = \left\{\left(\frac{E_p}{c}\right)(\Delta p_z)^{1/2}\right\} + \left\{\left(\frac{4\pi E_{min}}{c}\right)((\Delta p_z)^{1/2})\right\} - \left(\frac{\in_0}{c}\right)$$

Here, we can be using the energy equations 9(a-f) and not equations 12 (a-d) to avoid the complexities. We can also deduce an equation for p in terms of Δ_x, Δ_y and Δ_z as given below:

$$p = \left[K_1\left(\frac{1}{\Delta x}+\frac{1}{\Delta y}+\frac{1}{\Delta z}\right)\right] - K_2\left(\frac{1}{(\Delta x)^{1/2}}+\frac{1}{(\Delta y)^{1/2}}+\frac{1}{(\Delta z)^{1/2}}\right)^{1/2} \tag{12b}$$

Where:

$$K_1 = \left[\frac{h}{2C}(E_p + 4\pi\pi_1 + 4\pi\pi_0)\right] \tag{12c}$$

And:

$$K_2 = 2\left(\frac{E_0}{C}\right)\left(\frac{h}{2C}\right)^{1/2}[(E_p)^{1/2} + (4\pi\pi_1)^{1/2}] \tag{12d}$$

Equation (12b) is the deterministic equation for the momentum of a particle in terms of the respective uncertainties of the co-ordinate.

2.3 Momentum using Dirac's relativistic equation

The momentum can be calculated from Dirac's quantum relativistic equation:

$$E = \sqrt{p^2c^2 + m_0^2c^4} \tag{13}$$

Knowing E and m_0 of a particle, the momentum p can be calculated.

Equations 9(a-f) and (13) are both quadratic equation and E has two roots, which are equal in magnitude, but opposite in sign that correspond to Dirac's positive and negative energy states.

We shall now calculate (ΔE), from observational data, and then evaluate E, by substituting the same in equations 9(a-f).

3. Computation of energy *E*

Computation of energy E under different constraints will lead to interesting results:

$$(\Delta E)_{\mathrm{SD}} = \sqrt{\bar{E} - (\bar{E}^2)} \tag{14}$$

3.1 Single observer multiple observation

When an observer can make any number of observation (say n) for the energy E of a particle, and the values thus found are say $E_1, E_2, E_3, \ldots, E_n$.

The standard deviation (SD) of the said values of E is given by equation (14), where:

$$(\bar{E}^2) = \left(\frac{E_2^1 + E_2^2 + \cdots + E_n^2}{n}\right) \tag{14a}$$

and:

$$(\bar{E}^2) = \left(\frac{E_1 + E_2 + \cdots + E_n}{n}\right)^2 \tag{14b}$$

This statistical method required multiple observations to be made on the state to be measured.

3.2 Single observer single observation

The observer has only one opportunity to measure E: the observer finds the observed value of the energy of a particle as $\{E + (\Delta E)\}$, then equation (9a) and (9b) can be written as:

$$\{E + (\Delta E)\} = \{E_p^{1/2} + \sqrt{4\pi}E_p^{1/2}\}(\Delta E)^{1/2} - \in_0 (\Delta E) \quad (9c)$$

Similar, when the observed value of the energy of a particle is found to be $\{E + (\Delta E)\}$equation (9c) can be written as:

$$\{E + (\Delta E)\} = \{E_p^{1/2} + \sqrt{4\pi}E^{1/2}\}(\Delta E)^{1/2} - \in_0 (\Delta E) \quad (9d)$$

when the recoil photon (signal used to observe a particle) after interaction with the observable, looses energy (ΔE) is positive: and when the same gains energy in the process of interaction with observable, (ΔE) is negative equation (9a) and (9b) represents the two possible cases, respectively.

As, the left hand sides of equation (9a) and (9b) are known to an observer, the equation can be solved for finding (ΔE); which when substituted in equation (9d) gives the value of E.

3.3 A simplified algorithm for determination of total quantized energy E

It is shown that equation (9a) can be written as more general and simpler form in terms of " $\in_0$" is an universal constant as shown before and "n" represents integral whole numbers, $n = 1,2,3,\ldots,N$.

Substituting $(\Delta E) = \{n(\Delta E)_{\min}\}$ in equation (7), one gets:

$$E = \{(n)^{1/2} \in_0 + \sqrt{4\pi\pi}(n)^{1/2} \in_0\} - \in_0 \quad (9e)$$

or:

$$E = \{(n)^{1/2} \in_0 + \sqrt{4\pi\pi}(n)^{1/2} \in -1\} \in_0 \quad (9f)$$

$$\mu = \frac{\in_0}{E_p} = \frac{E_{\min}}{\in_0}$$

Putting $n = 1,2,3,\ldots$,N, etc. we can get them set of precise quantized energy states, as, $S_u = (E_1, E_2, \ldots, E_n)$ where N is the largest number, and $E_1 = \sqrt{4\pi}, E_{\min}$ and $E_N = (E_p/\sqrt{4\pi})$.

4. The deduction of graviton wavelength (λ_G) and energy (E_G)

It is assumed that the presently observable evolutionary universe is the effect of a massive explosion, the big bang which occurred initially at $t = 0$, but all the considerations regarding the calculations are done by take τ_p as the epoch time. Dutta (1995) in his paper presented the formula for calculating the matter density, the total matter content and initial volume of the universe, which was used to calculate the quantized energy of the said Graviton (E_G) (Milne, 1935):

$$(E_G) = 4(\pi h^2 H_0^2 C^2 m)^{1/3} \quad (15)$$

Here the item $4(\pi h^2 H_0^2 C^2 m)^{1/3}$ is a dimensional constant, and "m" is the mass of the body.

However, it may be mentioned here that, so far, all experimental efforts to detect gravitons have failed, and future experimenter, may design the detectors for detecting the gravitons radiated from a source of known mass according to the required sensitivity demanded by equation (15).

5. The discussion on the perspective for the need for a new look

Historically, the underlying ideas and the laws governing the classical mechanics has been developed in an elegant fashion from the time of Sir Isaac Newton and were applied in an ever widening range of dynamical systems until necessity for departure were clearly shown by experimental results. A very attractive new scheme, called quantum mechanics, was set up, which was more suitable for description of atomic scale phenomena including electro dynamics and optics, in some respects more elegant than, the classical scheme, not clashing with features of classical theory. Those could be incorporated in the new scheme. A galaxy of scientists like Max Planck, Neils Bohr, Erwin Schrodinger Max Born, Werner Heisenberg, Albert Einstein, Wolfgang Pauli and Paul A. M. Dirac among other (Heisenberg, 1986a, b; Born, 1986; Dirac, 1986) contributed in the process. One major limitation pointed out by Werner Heisenberg and supported by Albert Einstein was the HUP about which we have discussed at length and attempted to present a deterministic alternative for energy and momentum in the non-infinite non-zero quantized energy limits, that opens up technological possibility of by-passing uncertainity relations.

5.1 The limitations because of HUP

In the simplest language the HUP can be stated as, it is not possible to determine, measure, or know – simultaneously the position and momentum of a particle in the same level of accuracy: the more precise the measurement of a position, for example the less precise the knowledge of its momentum and vice-versa. That is a process of measuring its position alters its momentum unpredictably. Secondly, as we venture further and further into the subatomic world our vision becomes less and less clear – because there are limits beyond which we cannot measure accurately – (Dutta Majumdar, 1979; Dutta Majumdar and Majumdar, 2004a; Heisenberg, 1930; Roy and Dutta Majumdar, 1996; Roy *et al.*, 1996). The contrast between quantum theory and causal laws of classical physics, is evident Dirac in his article "The need for a quantum theory" (Dirac, 1932) made following two important statements (Dirac, 1986):

(1) … science is concerned only with observable things and that we can observe an object only by letting it interact with some outside influence.

(2) … there is a limit to the fineness of our power of observation and the smallness of accompanying disturbance – a limit which is inherent in the nature of things and can never be surpassed by improved technique or increased skill on the part of the observer.

From the discussion above it was imperative that we must revise our ideas of causality. There was an unavoidable indeterminacy in the calculation of straight forward observational results. In order to obviate the difficulty – a new set of accurate law's of nature were required and was provided by the principle of superposition of states (Born, 1986). It is important to remember that the superposition that occurs in quantum mechanics is of an essentially different nature from any occurring in classical theory – as the quantum superposition principle demands indeterminacy in the results of observations in order to be capable of a sensible physical interpretation.

5.2 Indeterminacy, observations and cybernetics

It is well known that the development of cybernetics as a modern discipline emerged following from Wieners' (1948) publications on the subject – when scientists and engineers faced with a set of problems concerned with control, communication and computation in dynamical systems – both in mechanization of intelligent activity in machines and living issues about "observed systems" Dutta Majumder in a series of papers (1975, 1979, 1999, 2000, 2004) enunciated his combined formalism of "Observer systems" "Observed systems" and the "act of observing" in the environment into one unitary discipline of general dynamical systems from the point of perspective, motivation, requirements, characteristics attributes and behaviour, and developed a unified general theory of systems and cybernetics in terms of causality, signal predictability and the notions of state in dynamical systems comprising of machines and human beings with successful implementations. From this theory we venture to conclude that all observations and interactions in machines and living tissues can be considered as cybernetic process.

Dirac's statement as quoted above published in 1958 – can be considered as a deterministic conclusion about indeterminacy, and observability should be taken as approximate with the emerging newer and newer mathematical tools, techniques and their advance realizations. Our contribution in this paper is a decisive proposal in that direction.

5.3 Indeterminacy limits and nano technology

It was in December 29, 1959 Feynman (1960) in his celebrated talk at the Annual Meeting of the American Physical Society entitled "There is plenty of room at the bottom" presented a technological vision of the miniaturization of materials, manipulating and controlling things in a small scale called "Nanotechnology". Feyneman visualized a technology using a toolbox of nature to build nanoobject – atom by atom by atom or molecule by molecule – with structural features in the range of about 10^{-9} to 10^{-7} m.

Nature seems to have bypassed or disregarded indeterminacy relations and has made many objects and processes that function on a micro to nano scale (Dirac, 1986) in a deterministic fashion. The understanding of these functions can guide us in initiating and producing new nanomaterials. Present day technology is fantastic – but it pales when compared to what will be possible when we learn to build things at the ultimate level of control one atom at a time.

We should also understand that, new behavior at the nanoscale may not necessarily be predictable from that observed at the molecular scale of to-day.

6. Conclusion

The philosophical foundation of quantum mechanics is based on the well known duality concept of complimentary notions namely – particles and continues, localized and non-localized characteristics of quantum behaviour expressed through the well known equations of energy and momentum as $E=(R/2\pi)\omega$ and $p=h\lambda^{-1}$, respectively.

These equations mainly manifest the qualitative aspect of quantum mechanics as the quantitative aspect is governed by the Heisenberg's uncertainty relations.

Logically in most general sense for any physical reality quality and quantity are interdependent and so qualitative dualism should have a hidden or virtual quantitative dualism is an outcome of this hypothesis that has manifested as the reality of quantitive dualism cum qualitative dualism as presented below:

- The generalized equations of energy and momentum as given by equations (7) and (10) are deterministic and algorithmically computable though expressed as functions of uncertainity terms.
- The four universal physical constants, H, C, G, and H_0 are utilized to impose the cutoffs on a dimensional basis.
- Similar cutoffs are also imposed on the uncertainity relations on the basis of dimensional, equivalence, thereby avoiding the observer-observed – observation interdependence phenomena to derive the cutoff energies Thus, the exclusion on the causes of determinacy renders the computation a deterministic status.
- Conventional determination of the uncertainity parameter ΔE requires the standard deviation to be calculated from a number of observations calculated in terms of (ΔE).
- The uncertainity of measurement of E is true even for a single measurement. If we take, a single measurement of the energy of a particle it gives a value $E=E\pm\Delta E$ which is known. Using equations 9(a-f) we can measure E.

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