American Journal of Modern Physics
2025, Vol. 14, No. 1, pp. 29-32
https://doi.org/10.11648/j.ajmp.20251401.13

Research Article

Quantum Theory of Uncertainty Principle or Indeterminacy Principle

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Abstract

The differential and integral forms of Indeterminacy principle or Heisenberg Uncertainty principle have been described in this paper. The uncertainty in the measurement of ΔE is not only due to the measurement of Δt and h but is also due to quantization factor Q. We have discussed Order-Disorder Transformation, Differential and Integral forms of Indeterminacy principle (Quantum Theory of Uncertainty principle), Quantum Representation and Action Quantization Process in details. We have used the Order- Disorder concept and established that the Heisenberg Uncertainty principle may be evaluated from Order-Disorder Transformation, i.e., Heisenberg Uncertainty principle is the special case of Order- Disorder Transformation. It may be pointed out that our modification of Uncertainty relation is consistent with the results in the range of variables where the modified relationship is valid.

Keywords

Quantum, Quantum Theory, Quantization of Energy, Order – Disorder Transformation, Heisenberg Uncertainty Principle, Indeterminacy Principle, Nature and Universe, Probability Distribution Function

1. Introduction

Quantum is a discrete quantity of energy proportional in magnitude to the frequency of the radiation it represents. [1] The concept of Quantum is a milestone in understanding progress of Physics in the interaction of matter with energy. The key to understand this interaction is the uncertainty relation originated by Heisenberg [2]. The quantization can be understood in terms of order and disorder phenomena in matter and radiation. [3] Bohr [4] also introduced the concept of energy level which explains emission and absorption of radiation at definite frequencies. Quantum theory is the keystone of the theory which is necessary for understanding subatomic level, atomic, molecular, macro level. In this paper the author has applied the concepts of order-disorder transformations [5] to generalize Heisenberg Uncertainty relation: the limits of application of the principle have been extended (The differential and integral formulation). [6]

Heisenberg has used the Uncertainty principle/ Indeterminacy Principle. In other words determinism and indeterminacy simultaneously determine the position and velocity, and mass and energy. The exact position and momentum of a particle can only be known with certain limits. This field of work was attracted to the best of minds. [7]

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Received: 17 December 2024; **Accepted:** 6 January 2025; **Published:** 10 February 2025

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2. Order-Disorder Transformation

Order and Disorder are two complementary phenomena. Every system possesses the behavior of order and disorder. Order refers to completeness- a quality of nature as it loves symmetry, while disorder refers to incompleteness- a quality of the universe created by nature and follows randomness. Order and disorder are just like two faces of a coin. The difference lies in having dual nature of disorder like matter and radiation.

Order and disorder follow systematic and unsystematic arrangements, respectively. The measurement of minimum values ΔO (ordered quantity) and ΔD (disordered quantity) simultaneously is difficult as Nature itself alters the situation i.e. due to opposite characteristics on probability ground. This may be expressed as:

$$\Delta O.\ \Delta D \sim \text{constant} \tag{1}$$

In general it has been shown that [8]:

$$\Delta O.\ \Delta D \rightarrow \Delta t.\ \Delta E \rightarrow \Delta t.\ \Delta T \sim \text{constant} \tag{2}$$

Under Order-Disorder concept the quantized form of energy wave function may be described by:

$$\Psi = \sin\left[(2\pi/\ \lambda)\ vt\right] \tag{3}$$

Let us consider that the probability distribution functional quantity f (O, D) may be described by:

$$[f\,(O,\ D)]\ {-1} = \lambda/vt = Q, \tag{4}$$

where Q is quantization factor.

Thus, we find:

$$\Psi = \sin\left[2\pi.\ f\,(O,\ D)\right] = \sin\,(2\pi/Q) \tag{5}$$

On applying the parity condition $\int\int \Psi\ \Psi^{*} = 1$ we find:

$$\int\int f\,(O,\ D)\ \Delta O.\ \Delta D = 1/2\pi \tag{6}$$

Where

$$f\,(O,\ D) = \exp\left[(E - EO)\ /\ ED\right] \tag{7}$$

i.e. in general it may be described as: [9]

$$\int\int f\,(O,\ D)\ \Delta O.\ \Delta D = \int\int f\,(t,\ E)\ \Delta t.\ \Delta E = \int\int f\,(t,\ T)\ \Delta t.\ \Delta T = 1/2\pi \tag{8}$$

This is called Order-Disorder Transformation (ODT) [5].

This agrees with the Heisenberg result: [2]

$$\Delta \upsilon.\ \Delta t = 1/2\pi \tag{9}$$

3. Differential and Integral Forms of Indeterminacy Principle

(Quantum Theory of Uncertainty principle):

In differential approach the indeterminacy principle or Heisenberg Uncertainty principle describes that it is impossible to measure simultaneously the minimum values of the conjugate members of the variables (q,p), (t, E), which describes the principles. [2]

$$\Delta\ q.\ \Delta\ p >= h/2\ \pi \tag{10}$$

$$\Delta\ t.\ \Delta\ E >= h/2\ \pi$$

While in integral approach the quantum form of Uncertainty principle/ Indeterminacy principle in Cartesian Euclidian concept takes the form as developed by author [10].

$$\int\int [2\pi\ f\,(O,\ D)]\ {-1} = \int\int \Delta O.\ \Delta D = Q/2\pi$$

$$\int\int [2\pi\ f\,(t,\ E)]\ {-1} = \int\int \Delta t.\ \Delta E = Q/2\pi \tag{11}$$

O and D correspond to order and disorder quantities and t and E corresponds time and energy. Detailed studies have been given below.

It is noticeable from the description of Uncertainty concept's and Order- Disorder Transformation hypothesis that the differential representation and integral representation follow a relationship of direct proportionality.

$$\Delta\ t.\ \Delta\ E \propto \int\int f\,(t,\ E)\ \Delta t.\ \Delta E \tag{12}$$

and that proportionality constant is Planck constant 'h', i.e.,

$$h = \Delta\ t.\ \Delta\ E\ /\int\int f\,(t,\ E)\ \Delta t.\ \Delta E \tag{13}$$

Here in eq. (13) the numerator quantity is concerned to Heisenberg Uncertainty principle and denominator quantity is associated to Order- Disorder Transformation,

$$\text{i.e., } h = (h/2\pi)\ /\ (1/2\pi) \tag{14}$$

In Schrodinger representation disorder moves in form of waves. The movement of a wave having a trough and crust possess a wavelength while movement of particles normally along horizontally develops a phase difference (λ-D), an order disorder transformation message, which provides wave amplitude. [11]

$$\Psi = \sin\left[(2\pi\ f(O,\ D)\right]$$

Or

$$\Psi = \sin\left[(2\pi/Q\right] \tag{15}$$

Every system possesses the behavior of order and disorder phenomena. Order Disorder Transformations (ODT) consideration in polar Euclidian concept provides [12]

$$[2\pi f(O, D)] = \theta = \omega t = 2\pi \nu t = 2\pi / Q \quad (16)$$

where ν is radiation frequency, ωt is angle subtended at center by chord of length . f(O, D) is distribution function and Q = / c t.

The relationship $f(O, D) = \nu t/\lambda = Q^{-1}$ is the variation of f(O, D) corresponding to the variation of angular area of circular surface. The radius of that circular surface is varying over integral surface area ∫∫ΔO. ΔD(Euclidian space), which follows as given by (eq. 11):

$$\int\int [2\pi f(O, D)]^{-1} = \int\int \Delta O.\ \Delta D = Q/2\pi$$

and balances the functions of order disorder phenomena.

Accordingly, author describes that order disorder probability distribution function f(O, D) in association with uncertainty principle in integral space ∫∫ΔO. ΔD constitute Order Disorder Transformations (ODT) hypothesis.

4. Quantum Representation

Let us represent equations of Planck, de Broglie and Heisenberg in quantum form. Considering Quantization factor 'Q' = λ / c.t or λ / v.t.

Planck's equation leads to:

$$E = h/t.\ (1/Q) \quad (17)$$

which gives ordered form of energy as E=h/t for maximum quantization Q →1. For disordered form of energy

$$(h/\Delta t) / \Delta E = Q;\ Q < 1 \quad (18)$$

De Broglie equation [13] gives cp=h/t (1/Q) which for maximum quantization condition Q →1 gives cp=E=h/t which is ordered form of energy. Disordered form of energy representation is same as followed in Planck's equation representation.

Heisenberg Uncertainty Principle is described by:

$$(h/\Delta t)/ \Delta E \leq 2\pi \quad (19)$$

Comparing eqs. (18) and (19), it is noticed that right hand side quantities ≤Q is somewhere related to 1 and 2π. It is noticeable that uncertainty in the measurement of ΔE is not only due to the measurement of Δt, h but also due to quantization factor Q. When we include quantization factor Q in Heisenberg uncertainty principle, we find [(h/Δt)/ ΔE] =2πQ, which for the value of Q [Q=1/2π] provides some correct meaning in terms of order and disorder. Q →1 is for ordered state while Q<1 is for disordered state, which is associated with entropy.

Representation of 2π inside a spherical representation may be fruitful in three-dimensional representation of Energy, Time and Cosmic power. Thus, it may be concluded that quantization of Energy factor, 1/2π, 'Δt' and 'Q' is affecting uncertainty principle i.e. measurement of ΔE is affected by three factors, 1/2π, 'Δt' and 'Q'. This conclusion inspired me to move towards the description of A Quantum Model, where Nature (Order), Universe (Disorder), Superpower (God) are considered in three-dimensional representation in Quantum conceptual way. [14]

5. Action Quantization Process

Order- Disorder Transformation reflects that determinism and indeterminacy happens in every action or event. [15] It is known that quantization of energy is an action process. The happening of every action or event may be represented by **A** as described by:

$$\mathbf{A} = f(O, D) = (\lambda/\nu t)^{-1} = 1/Q \quad (20)$$

Quantization Q is associated distribution function f (O, D).

i.e. every action or event is a quantization process. The happening of an action or event may be either in ordered state or in disordered state. The contribution of ordered energy and disordered energy in the action process may be described in the following way [10]:

$$f(O, D) = \exp[(E - E_O) / E_D] = (\lambda/\nu t)^{-1} \text{ or } (\lambda/ct)^{-1} = 1/Q \quad (21)$$

For $E = E_O$, $Q_1 \rightarrow 1$. For $E_O = h/t$, the above condition holds good for E is not equal to E_O, Q<1. Such situation is associated with ordered and disordered states. It also reflects that whenever the impurity level of disordered matter or energy goes on decreasing, the possibility of attainment of an ordered state arises, such happening may also be visualized in the following resemblances of quantization conditions.

$$Q = \lambda/ct = h/pct = E_O/E;\ Q_1 = f(O, D) = \exp[(E - E_O) / E_D] \quad (22)$$

For $Q = Q_1$, we finally obtain:

$$[1 - (E_O / E)]\ [1 + (E_D / E)] = 0 \quad (23)$$

Above equation reflects that, the order factor E_O / E and disorder factor E_D / E affect a system or body in opposite ways. Also, increasing or decreasing of disorder factor has more effect than a variation of the order factor. Quantization value assesses that whenever a system or body is in ordered state or disordered state we have:

$$(h / \Delta t) / \Delta E = Q \quad (24)$$

From Heisenberg Uncertainty principle, we may say that:

$$[(h / \Delta t)\ (1/2\pi) / \Delta E] \leq 1 \quad (25)$$

From the above representation it is revealed that the uncertainty is due to Q effects. For the ordered state Q=1. When we include factor Q in eq. (25) we find:

$$[(h / \Delta t)\ (1/2\pi) / \Delta E] \leq 2\pi Q \quad (26)$$

which for the value of Q (Q=1/2π) takes the form of eq. (25). The symbol ≤ represents equality (=) sign for ordered state and less than (<) sign for disordered state. Also (≤) represents both order and disorder states together. All this shows that Q should be included in Heisenberg's representation. eq. (26) i.e $\Delta E.\ \Delta t \leq Q(Q: 1/2\pi, 1)$ [11].

6. Result and Concluding Remarks

(i) It is noticeable that uncertainty in the measurement of ΔE is not only due to the measurement of Δt, h but also due to quantization factor Q.

(ii) The symbol ≤ represents both order and disorder states together. All these show that Q should be included in Heisenberg's representation. It is also justified that the Uncertainty principle as described by eq. (11) of integral form is universally true.

(iii) Quantum theory of Uncertainty principle in Euclidian space is finally valid as given by eq. (11)

$$\int\int [2\pi\ f(O, D)]^{-1} = \int\int \Delta O.\ \Delta D = Q/2\pi$$

which is also called as Indeterminacy principle or Uncertainty principle.

In general this may be concluded that the Heisenberg Uncertainty principle may be evaluated from Order- Disorder Transformation, i.e., Heisenberg Uncertainty principle is the special case of Order- Disorder Transformation

It may be pointed out that our modification of Uncertainty relation is consistent with the results in the range of variables where the modified relationship is valid.

Abbreviations

ODT	Order Disorder Transformations
Eq	Equation

Acknowledgments

The author is highly grateful to Prof. M. S. Sodha for continuously monitoring the manuscript.

Author Contributions

S. K. Srivastava is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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