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The Principles of (Partial Locality, Partial Indeterminacy, Partial NonLocality) and (Multi Locality, Multi Indeterminacy, Multi NonLocality)

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Abstract: This article introduces new neutrosophic principles aiming to extend and generalize the concepts of locality and nonlocality by addressing scenarios involving indeterminacy, together with partiality and multitude, in physics, mechanics, cosmology, biology, medicine, chemistry, economics, ecology, sociology. Locality refers to interactions or processes confined within a limited region of space or time. But there may be a Total (100%) Locality, or a Partial Locality (less than 100% and greater than 0%). The effects are constrained to the immediate environment. Contrariwise, NonLocality refers to interactions or connections between entities separated by space or time. The changes in one location have instantaneous effects on another. Similarly, there may be a Total (100%) NonLocality, or a Partial NonLocality (less than 100% and greater than 0%). Total (100%) or Partial (less than 100% and greater than 0%) Indeterminacy may arise from hidden variables and from environment. For instance, it may involve nonlocal connections between objects that are only partially entangled or influence each other in limited ways, rather than exhibiting complete freedom. The Principle of Partial Locality, Partial Indeterminacy, and Partial NonLocality implies an interplay of locality, indeterminacy, and nonlocality acting in a dynamic neutrosophic system. A generalization of (Locality, Indeterminacy, NonLocality) is the (MultiLocality, MultiIndeterminacy, MultiNonLocality). Practical examples from different fields are provided.

Keywords: locality, indeterminacy, nonlocality, multilocality, multiindeterminacy, multinonlocality, multiaction at a distance, universal gravitation, superposition, superluminal, quantum physics, quantum computing, quantum field theory, quantum information, quantum entanglement, Bell Inequality, hidden variables, dark energy, dark matter, electromagnetic forces, Bohmian mechanics, Copenhagen interpretation, cell (in biology), paracrine, CPU caches, Latent Dirichlet Allocation, curling, pollination, trophic cascade.

1. Introduction

Let's start by briefly discuss —with simple, quasi-random examples— the concepts of locality and non-locality, and then explain and illustrate some theoretical hidden variables parameters in scientific models.

In ecosystems, the interactions within and between ecosystems can show both local and nonlocal characteristics. Migratory species travel sometimes vast distances[1] between different ecosystems, yet their migration patterns connect those distant ecosystems, meaning their presence and behaviors have nonlocal effects and exert widespread consequences on food webs, predator-prey relationships, or nutrient cycling across regions, whilst daily interactions within a specific local habitat, such as

[1] In Tanzania's Serengeti region, plains animals, especially wildebeests (*Connochaetes taurinus*) and zebras, migrate over 1,600 kilometers (1,000 miles) seasonally [Dorst 2024].

feeding, mating, and nesting behaviors, are local.[2] Keystone species[3] have disproportionate effects on their ecosystems relative to their abundance.[4] This type of nonlocal effects (known as the 'trophic cascade'[5]) illustrate how changes in one species can ripple throughout the ecosystem, shaping environmental conditions and affecting other species that are far removed from the original source of change.

The effects of a collision between two objects are local to the region of contact. When two curling[6] stones[7] collide, the forces exerted and the resulting changes in motion are confined to the immediate area where they touch. Velocity and direction, as any other interactions and resulting effects, are purely local to the point of impact.[8]

The production of car parts in a local factory involves local labor, resources, and economic interactions. The final assembly of a car often involves sourcing parts from various countries. Disruptions in one part of the supply chain (e.g., a factory shutdown in one country) can have significant nonlocal effects, impacting production schedules and economic conditions in other parts of the world.[9]

Hidden variables are theoretical parameters or entities in scientific models that are not directly observable but are postulated to exist in order to explain certain phenomena [Kochen et al. 1975].

[2] Such as the herds of caribou (*Rangifer tarandus*) that settle during the summer in the barrens, which are relatively flat wastelands with sparse vegetation, while, in July, they begin an irregular southward migration, and they spend the winter in the taiga, where each herd moves according to local conditions, lacking a well-defined pattern [Dorst 2024].

[3] Elephants (*genus Loxodonta*), for example, are considered as "ecosystem engineers" because they modify their environment by dispersing seeds, uprooting trees, or creating water holes, stimulating "plant richness to peak (…), setting up a creative browsing-grazing tension and a patchwork of habitats" [Western et al. 2021].

[4] The reintroduction of gray wolves (*Canis lupus*) in Yellowstone National Park in 1995/1996 after a 70-year absence has led to cascading effects on the entire ecosystem, including the recovery of aspen trees, which provide habitats for birds and other species. Wolves are apex predators that hunt large herbivores like elk. By reducing elk populations, overgrazing is prevented, and vegetation is allowed to recover [Ripple et al. 2012; Farquhar 2023].

[5] American zoologist Robert Paine coined the term in 1980's to describe changes in food webs caused by manipulations of predators. Others employed the term to describe changes in aquatic ecosystems arising from factors such as sudden increases or dramatic declines in predatory fishes, caused, e.g., by overfishing [Carpenter 2023].

[6] Curling is an ice-played game akin to lawn bowls, where two teams – each consisting of four players – compete, sliding round stones across the ice toward a target (button). The stones are concave at the bottom and have a handle on top. The button is located at the center of a circle marked with concentric rings (house). The aim of the game is for each team to position their stones as close to the center as possible. For more info on this game, see Britannica – The Editors of Encyclopedia. "curling". Encyclopedia Britannica, 11 Apr. 2024, https://www.britannica.com/sports/curling. Accessed 26 June 2024.

[7] Curling regulations specify that a curling stone can weigh up to 20 kilograms, with most stones typically weighing between 17 and 20 kg. Additionally, the maximum permissible circumference of a stone is 36 inches (910 mm), while the minimum height is 4.5 inches (110 mm). The substantial weight allows the stone to glide the length of the rink without slowing down too soon.

[8] The curl distance for a curling stone, given a typical angular velocity (four rotations over 28.35 meters in 23 seconds, equivalent to 1.09 rad/s or 62.6°/s), ranges from approximately 0.5 to 1.5 meters when aimed at a circular target 28.35 meters away on ice. Various factors influence these curl distances, including the ice surface conditions (such as temperature, pebble density, and the size and shape of the pebbles) and the characteristics of the curling stones themselves. [Kameda et al. 2020]

[9] In recent decades, economic globalization has led to a substantial shift of manufacturing to regions with lower perceived costs, notably moving production to China and other Asian countries. Although this approach initially seemed economically sensible, its significant downsides have become apparent in the past three years. Consequently, many industries, especially the automotive sector, are now embracing a "local for local" production strategy, particularly with the shift towards electric vehicles. [Abuelsamid 2022]

Bohmian mechanics[10] offers an interpretation of quantum mechanics by introducing hidden variables to translate quantum phenomena "in an objective way using deterministic dynamics" [Dabin 2009, 40], unlike the standard inherently probabilistic Copenhagen interpretation. According to this theory, particles possess definite positions at all times even when unobserved. These positions are hidden variables guided by a "pilot wave" [Goldstein 2024]. Valentini has expanded this theory to incorporate signal nonlocality, enabling entanglement to function as an independent communication channel, and thus eliminating the need for a secondary classical "key" signal to "unlock" the message encoded in the entanglement [Valentini 1991, 2009].

Two concepts proposed in cosmology to explain observable phenomena such as galaxies' rotation curves and the universe's rapid expansion, and deduced from gravitational effects on visible stuff and the universe's large-scale structure, are *dark matter* and *dark energy*.[11] They are also hidden variables. The observable universe consists of *matter*, which occupies only 5% of the cosmos. The remaining 95% is made up of *dark matter* (27%) and *dark energy* (68%), mysterious substances still under investigation by scientists.[12] Normal matter, composed of protons, neutrons, and electrons, can be seen directly or through telescopes. Dark matter, however, does not interact with light, making it invisible.

Latent variables are employed to model topics in machine learning. Latent Dirichlet Allocation (LDA) is a three-level hierarchical Bayesian model that identifies hidden subjects in a set of documents. It depicts each item in a collection as a finite mixture over a set of topics, and each topic as an infinite mixture over a set of topic probabilities [Blei et al. 2003].

In the construction of measurement models for psychological data (psychometrics), *latent traits* —describing veiled psychological abilities or skills like motivation, or anxiety, so on— are hidden variables, being not immediately quantifiable, but only inferred from outcomes of genetic profiles and psychological tests. [Hambleton&Cook 1977, 75].

Certain *genetic mutations* (alterations) —that are are not readily visible, but can be found by genetic testing— raise the risk of an individual of developing cancer or other serious health issues.[13]

In the study of *infectious diseases*, *asymptomatic carriers* are individuals who harbor a pathogen without showing symptoms and can transmit the disease to others. The presence of these carriers is a hidden variable in epidemiological models, complicating efforts to track and control the spread of infections.[14]

2. The Principles of Locality, NonLocality, and Neutrosophic Locality

2.1. ***The Principle of Locality***

The Principle of Locality means that an object is influenced directly only by its immediate surroundings.

Let's briefly review a few cases from various fields.

[10] Also known as the de Broglie-Bohm theory, proposed by Louis de Broglie in 1927 and reshaped by David Bohm in 1952.

[11] The concepts were proposed in the 20th century by Fritz Zwicky, and confirmed by Vera Rubin in the 1970s.

[12] Percentages estimated by the European Space Agency (ESA), https://www.esa.int/Science_Exploration/Space_Science/What_are_dark_matter_and_dark_energy. Dark matter and dark energy stories are updated continuously on United States National Aeronautics and Space Administration (NASA) website, https://science.nasa.gov/universe/dark-matter-dark-energy/.

[13] See, for example, a case study about risks and mechanisms of cancer in women with inherited susceptibility to epithelial ovarian cancer [Shulman 2011].

[14] See, for example, a case study about Coronaviruses SARS-CoV, MERS-CoV, and SARS-CoV-2 in asymptomatic pediatric population [Aleebrahim-Dehkordi et al. 2021].

2.1.1. *Computer Science*: CPU Cache

In computer architecture, locality is a key principle in the design of memory hierarchies. For example, if a particular memory location is accessed, it is likely to be accessed again in the near future (this is called *temporal locality*). Also, if a particular memory location is accessed, nearby memory locations are likely to be accessed soon (and this is called *spatial locality*). CPU caches[15] exploit these principles by locally storing frequently accessed data, close to the processor, to minimize access time and improve performance.

2.1.2. *Biology: Cellular Processes*

Cell signaling often operates on a local level. For example, paracrine[16] signaling involves the release of signaling molecules[17] from one cell that affect nearby target cells. These molecules typically do not travel far from their point of release. Their effects are localized to the immediate cellular environment.

2.1.3. *Ecology: Habitat Interactions*

In many ecosystems, pollination[18] is a local process. Bees, butterflies, and other pollinators typically collect and transfer pollen within a specific area. The interactions between plants and their pollinators occur in close proximity, and the effects[19] are localized to that region [Kevan 2001; 2020].

2.1.4. *Medicine: Local Anesthesia*

Local anesthetics are used to numb a part of the body during minor surgical procedures. When a local anesthetic is administered, its effects are confined to the targeted area, blocking nerve signals and preventing pain in that specific region while the patient remains unaffected elsewhere.

2.1.5. *Chemistry: Chemical Reactions*

In a simple acid-base neutralization reaction,[20] the interactions and resultant effects (like the formation of water and salt) occur at the molecular level in the immediate vicinity where the reactants come into contact. The reaction is localized to the solution where the chemicals are mixed.

2.1.6. *Sociology: Community Dynamics*

Neighborhood Watch Programs[21] are examples of local initiatives where community members collaborate to monitor and improve safety within their immediate area. The actions and effects[22] of these programs are confined to the neighborhood level.

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[15] A short but comprehensive introduction in CPU Cache offers *Britannica* – The Editors of Encyclopaedia. "cache memory". Encyclopedia Britannica, 20 May. 2021, https://www.britannica.com/technology/cache-memory. Accessed 23 June 2024.

[16] More on the paracrine control can be read on *Britannica* – Utiger, Robert D. "human endocrine system". Encyclopedia Britannica, 17 Apr. 2019, https://www.britannica.com/science/human-endocrine-system. Accessed 24 June 2024.

[17] Like growth factors.

[18] A basic but extended entry about pollination can be read here: The Editors of Scholarly Community Encyclopedia "Efficient Pollination Technology of Crops", https://encyclopedia.pub/entry/40852. Accessed 20 June 2024.

[19] Successful pollination and subsequent seed production.

[20] Such as mixing hydrochloric acid (HCl) with sodium hydroxide (NaOH).

[21] Read more about the US program and statistics of crime prevention through neighborhood collaboration on the National Neighborhood Watch (a Division of the National Sheriffs' Association) website: https://www.nnw.org.

[22] These would be reducing crime rates and increasing community cohesion.

2.1.7. *Economics: Local Markets*

Farmers' markets operate on a local scale, involving transactions between local farmers and consumers. The economic activities are confined to a specific geographic area, and the effects (exchange of goods, pricing, and consumer satisfaction) are localized to the community where the market takes place.

*2.2. **The Principle of Non-Locality***

The Principle of Non-Locality (Instantaneity), or Action at a Distance, means that an object is influenced by another object without being in physical contact (e.g., gravity, Colomb's Law, Electric Forces, and so on).

2.2.1. *Physics: Quantum Entanglement*

In quantum mechanics, entangled particles exhibit nonlocal behavior. When two particles become entangled, the state of one particle is directly related to the state of the other, regardless of the distance separating them. If you measure the spin of one entangled particle, the spin of the other particle is instantly known, even if they are light-years apart. This phenomenon has been experimentally confirmed and is a cornerstone of quantum mechanics, defying classical intuition.[23]

2.2.2. *Classical Physics: Gravitational and Electromagnetic Forces (pre-relativity)*

Gravitational and electromagnetic forces were thought to operate at a distance instantaneously prior to the postulation of relativity. Two masses exert an attractive force on one other regardless of distance, with no apparent intermediate impact, according to Newton's law of universal gravitation.[24] Equally, Coulomb's inverse-square law[25] is an experimental physical law that determines the amount of force between two electrically charged particles at rest.

2.2.3. *Computer Science: Blockchain Technology*

The verification and recording of transactions in blockchain systems demonstrates nonlocal interactions. Many nodes must validate a transaction that is broadcasted to the network. The consensus process[26] ensures that all nodes agree on the blockchain's current state. Proving nonlocality, the addition of a new block or other changes to the blockchain are immediately returned throughout the network.

2.2.5. *Genetics: Epigenetic Modifications*

Epigenetic changes[27] can have nonlocal effects across generations. Environmental factors like diet, stress, and exposure to toxins can cause epigenetic modifications that do not change the DNA sequence but affect gene expression. These changes can be passed down to offspring, influencing their development and health.

2.2.6. Ecology: Ecosystem Dynamics

Migrations of a vast numbers of individuals from diverse taxa occur worldwide. It plays a crucial role in transporting nutrients, and other organisms, as they forage and are preyed upon. The

[23] See, for example, a paper on the exploration of the relationship between quantum nonlocality and entanglement [Cao et al. 2023], or on quantum entanglement without nonlocal causation [Pettini 2023].

[24] Britannica, The Editors of Encyclopaedia. "Newton's law of gravitation". Encyclopedia Britannica, 12 Apr. 2024, https://www.britannica.com/science/Newtons-law-of-gravitation. Accessed 2 August 2024.

[25] Britannica, The Editors of Encyclopaedia. "Coulomb's law". Encyclopedia Britannica, 25 Jul. 2024, https://www.britannica.com/science/Coulombs-law. Accessed 2 August 2024.

[26] Such as *Proof of Work* or *Proof of Stake*, used to verify new cryptocurrency transactions [Napoletano 2023].

[27] Such as DNA methylation [Moore 2013].

movement of migrating species across extensive spatial scales influences the ecosystems through which these animals travel. Hidden variables include the genetic traits or physiological states of migratory species that determine their migration patterns and behavior. [Cohen et al. 2020], [Bauer et al. 2014], [Garcia et al. 2024]

2.3. Principle of Partial Locality, Partial Indeterminacy (because of the hidden variables that may influence the object), and Partial Non-Locality

We propose for the first time the Principle of Partial Locality, Partial Indeterminacy (because of the hidden variables that may influence the object), and Partial Non-Locality, which we call the Principle of Neutrosophic Locality.

The Aharonov-Bohm effect, which is a quantum mechanic phenomen, proved that: an electrically charged particle is affected by an electromagnetic potential that is totally outside of the particle (the particle being situated in a region where the intensity of the magnetic field is zero).

This Non-Locality event, first observed by the Soviets, was later on investigated by other secret services in order to control the Human Psyche from a distance.

The Action at a Distance may be:

i. Continuous action;
ii. Quantized action, or action by quantas, which are small subdivisions of physical processes and phenomena of a particular system.

We may call it infinitdecimally discrete action.

3. Degree of Locality, Degree of NonLocality, and Degree of Indeterminacy (neither Locality, nor NonLocality)

3.1. Degree of Locality

Locality means that an object is directly influenced only by its immediate surroundings. The Degree of Locality measures the degree to which a system or interaction follows this principle. A high degree of locality indicates that there is little to no effect from far-off particles or events, meaning that the interactions are very limited.

3.2. Degree of NonLocality

The phenomenon known as NonLocality describes the ability of particles that are distant in space to instantly display linked actions by a Degree of NonLocality in the system. Strong correlations between far-off particles or systems indicate a high degree of nonlocality.

3.3. Degree of Indeterminacy (neither Locality nor NonLocality)

There are situations when uncertainty or lack of definitive behavior falter in terms of locality and nonlocality, therefore the system does not exhibit clear characteristics of either local or nonlocal interactions. The Degree of Indeterminacy quantifies the degree to which the behavior of a system defies simple classification as exclusively local or completely nonlocal. When a system displays behaviors that are unclear, inconsistent, or that don't easily fit into the categories of locality or nonlocality, it is said to have a high degree of indeterminacy.

3.4. Measuring These Degrees

To quantify these degrees in practice, one typically relies on experimental setups that test the correlations between particles or systems, such as:

- **Bell Inequality Test** is a "real-world physics experiment designed to test the theory of quantum mechanics" against the concept of local realism[28]
- Theories of Local Hidden Variables aim "to attribute 'hidden' definite outcomes to any potential measurement on a quantum system" [Bertlman 2023]
- **Neutrosophic Statistical Analysis** [Smarandache 2013] evaluates indeterminacy by analyzing the variance and distribution of measurement outcomes to see if they defy categorization into local or nonlocal.

4. Recapitulation, generalization, and applications

Quantum Non-Locality states that a quantum particle instantaneously knows the state of – and correlates the behavior with – other quantum particle.

Quantum Entanglement asserts that two entangled particles correlate their behaviors simultaneously (therefore faster than light), as such our faster-than-light speed hypothesis has been confirmed.

John Clauser, an American physicist, in 1970's, and Alain Aspect, a French physicist, in 1980's, has proved that the entanglement is real, and, as a consequence, the superluminal speed is real.

Faraday said that some medium transmits the electrical force (not action at a distance).

Quantum Teleportation is the transfer from sender to receiver of quantum information, whose basic unit is the qubit.

The Copenhagen Interpretation of "wave-particle duality" that "the electron travels as a wave and is detected as a particle", and "an electron is in more places at the same time" are popular (mis)interpretations.

The behavior of a particle is described by a wave fluctuation (ψ) that has the shape of an equation.

The wave-particle duality is actually the indeterminate part of the neutrosophic form of the electron, because it fluctuates between – or is a superposition of – the opposites (wave vs. particle).

Locality (or Local Causality) was named by Bell; others called it later local realism.

Bell's Inequality: In Quantum Mechanics, when electrons are sent across the magnetic field, half of the electrons get deflected towards to the right, and the other held to the left.

Violation of Bell's Inequality: In Experiments the predictions of local realistic models disagree with those of quantum mechanics.

Realism means the assumption that measurement outcomes are well-defined prior to and independent of the measurements.

We now introduce for the first time Partial Locality Causality, Partial NonLocal Causality, and Partial Indeterminate Causality.

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Partial Locality means that an object is influenced only partially by its immediate surroundings.

Similarly, Partial NonLocality means that an object is only partially influenced by another object without being in physical contact.

Partial Indeterminacy means that it is not clear that an object is influenced either by its immediate surroundings, or by another object without being in physical contact, or by both.

Such behavior is exhibited by an ambiguous, vague, incomplete, or inconsistent system.

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Quantum Physics defy the Classical Physics, because the behavior of erattic atomic and subatomic particle.

The degrees of locality, nonlocality, and indeterminacy may be measured for each system, upon the interactions between touching objects (Locality), non-touching objects (NonLocality), and the influence of hidden variables (Indeterminacy) on these interferences.

[28] See *Scholarly Community Encyclopedia*, "Bell Test Experiments.". Available online: https://encyclopedia.pub/entry/36569 (accessed on 02 August 2024).

Quantum Physics: The correlation between particles can be tested by experiments. At the quantum level, the degree of NonLocality may be measured by checking in what degree the test results violate the Bell Inequalities.

Degree of Indeterminacy by using statistical analysis: comparing the means, mediums, standard deviations, variance, distributions of the outcomes.

Degree of Locality: Predictions versus real measurement outcomes. That may be compared to the models of hidden variables.

Entangled Particles: In quantum physics, the state of one particle has an instantaneous effect on the state of its entangled particle, no matter how far away they are of each other. This is NonLocality.

By measuring the spin of one particle, the spin of its entangled particle is immediately known, defying the classical physical intuition.

Epigenetics study the heritable traits, that do not change the DNA sequence, and may result from normal development or from environmental conditions, such as stress, tocins, diet, etc. DNA methylation, as a strong epigenetic change, has nonlocal effects across generations, therefore passed down to offsprings.

Ecosystems: The presence or absence of a species in an ecosystem has cascading effects on the whole chain of species in that ecosystem. These are NonLocal effects. Local effects: feeding, mating, nesting together, or predatory-prey relationships, or plants that are pollinated by insects. NonLocal and Local Effects occur by the interaction between the ecosystems. For examples, the whales travel long distances from a sea (or ocean) zone to another water zone, connecting various ecosystems (NonLocality). Similarly the migratory birds.

Blockchain Systems: Social Networks, Brain Networks (neuronal interactions), Financial/Economic/Commercial/Cultural/Political etc. Networks function as blockchain systems, where the NonLocal interactions facilitate the transactions between multiple nodes.

If two nodes are adjacent, the communication between them is Local, but for non-adjacent nodes it is a NonLocal interaction.

Each node has two types of functionalities: Local and NonLocal simultaneously.

In general, in an open system, its elements has practically local interactions, partially nonlocal interactions, partially indeterminate interaction when the hidden variables of the environment influence the decoherence process.

5. MultiAction at a Distance and (MultiLocality, MultiIndeterminacy, MultiNonLocality)

5.1. MultiNonLocality caused by MultiAction at a Distance in Newton's Law of Universal Gravitation and in Superposition

Electromagnetic and gravitational forces instantaneously act at a distance. Newton's Law of Universal Gravitation states that, in the universe, a particle attracts another particle with a force that is direct proportional with the product of their masses, and inversely proportional with the square of the distance between them.

For objects, their masses are considered concentrated at their centers of gravity.

$F = G \cdot \frac{m_1 m_2}{r^2}$,

where F = attraction force; G = the universal gravitational constant; m_1, m_2 = the masses of the two particles (or objects); r = the distance between the two particles (or objects).

Herein too, we have a MultiAction at a Distance, for example many objects at various altitudes starting to fall on the Eart at the same time. SO, the Earth has an action (attraction) at a distance on each object separately, or MultiNonLocality.

5.2. MultiNonLocality caused by MultiAction at a Distance in Superposition

The Superposition Principle enables us to calculate the force exerted on a charge by considering the effects of multiple other charges. To illustrate, let's consider three charged particles. Using Coulomb's Law, we can determine the force between any pair of these particles. According to the

Superposition Principle, the total force acting on any single charge is the vector sum of the individual forces exerted by each of the other charges, as if each of these charges were the only one present. This means that we add up the forces from each charge independently to find the overall force on the target charge.

5.3. Coulomb's Law in scalar form

The Coulomb's Law in scalar form is the following:

$$|F_{12}| = k_e \cdot \frac{|q_1| \cdot |q_2|}{r_{12}^2} = \frac{|q_1| \cdot |q_2|}{4\pi\varepsilon_0 \cdot r_{12}^2}$$

where F_{12} = the electrostatic (attractive or repulsive) force between point charges q_1 and q_2

q_1, q_2 = point charges

r_{12} = distance between charges q_1 and q_2

k_e = Coulomb's constant

$k_e = \frac{1}{4\pi\varepsilon_0}$, where ε_0 is the electric constant

$|\ |$ means absolute value.

Coulomb's Law states that the absolute value of electrostatic force between two charged particles (points) is directly proportional to the product of the magnitudes square of the distance between them (similar to the Newton's Law of Universal Gravitation).

Opposite charges attract each other, while the like charges repel each other.

5.4. Superposition Formula

For multiple charges, the total force on a particular charge is the vector sum of the forces exerted by all other charges.

$$F_i = k_e \sum j \neq i \frac{q_i q_j}{r_{ij}^2} \widehat{r_{ij}}$$

where r_{ij} is the unit vector from q_i and q_j.

The Law of Superposition is an extension of Coulomb's Law from two to three or more point charges, for linear bilateral networks.

On a single point charge many forces act from the other point charges:

Therefore, one has some multi-action at a distance, and correspondingly MultiNonLocality.

5.5. *MultiLocality* results from a group of things that touch and influence together two by two.

5.6. While *MultiIndeterminacy* is produced by hidden variables, unclear environments, uncertainty between many Local and NonLocal interactions, as a result of MultiActions locally and MultiActions at a Distance.

Conclusion

In this article, we introduced a new neutrosophic principle (The Principle of Partial Locality, Partial Indeterminacy, and Partial Non-Locality) that extends and generalizes the concepts of locality and nonlocality by addressing scenarios involving indeterminacy. Locality pertains to interactions confined within a limited space or time, with effects restricted to the immediate environment. In contrast, nonlocality refers to interactions between entities separated by space or time, where changes in one location instantly affect another without intermediaries. Indeterminacy involves hidden variables, such as nonlocal connections between partially entangled objects. This principle works within a dynamic neutrosophic system.

The Principle of Partial Locality, Partial Indeterminacy, and Partial NonLocality implies an interplay of locality, indeterminacy, and nonlocality acting in a dynamic neutrosophic system. A

generalization of (Locality, Indeterminacy, NonLocality) is the (MultiLocality, MultiIndeterminacy, MultiNonLocality).

MultiLocality results from a group of things that touch and influence together two by two. *MultiIndeterminacy* is produced by hidden variables, unclear environments, uncertainty between many Local and NonLocal interactions, because of MultiActions locally and MultiActions at a Distance. While *MultiNonLocality* is caused by a MultiAction at a Distance. Practical examples from different fields were provided.

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