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Complex Mechanics and Emerging Forces: From Gravity to the Evolution of the Genetic Code

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Abstract

The aim of this paper is to demonstrate that the gravitational and electrostatic force are emerging phenomena that stems from the fractal difference between the constituants of a complex system but not effect of the motion of particles. The attractiveness or repulsiveness depending on the magnitude of the fractal difference between the constituents of a complex system. If the magnitud of a fractal difference between components of a complex system tends towards $+\infty$, attraction emerges, and if the magnitud of the fractal difference between components of a complex system tends towards 0, repulsiveness emerges.

Keywords: complex mechanics, emerging phenomenon, fractal difference, complex system, magnitud, particle.

Introduction

In a 1926 letter to his physicist friend Max Born, Einstein wrote: "Quantum mechanics is certainly impressive. But an inner voice tells me that it is not yet the real thing. [...] In any case, I am convinced that He does not play dice." In 1927, at the Solvay Conference, when Einstein uttered his famous phrase "God does not play dice" before the leading physicists to criticize Heisenberg's uncertainty principle, Bohr reportedly retorted to Einstein, "Einstein, stop telling God what to do."

Einstein opposed the Copenhagen School, led by Niels Bohr, which argued that the behavior of atomic particles (such as the electron) is governed by probabilities rather than absolute certainty.

This debate is a century old, and history seems to have vindicated the Copenhagen school, but this work, revisiting this intellectual discussion from the perspective of fractal geometry introduced by Benoît Mandelbrot in the mid-1970s [1], seems to lean towards Einstein's arguments.

Mandelbrot developed the fractal theory to describe complex and irregular shapes in nature.

This work posits that using fractal geometry instead of Euclidean geometry to study the changing positions of objects in space and time leads to the conclusion that physics is deterministic from the infinitely small to the infinitely large, as Einstein aptly summarized in his famous phrase, "God does not play dice."

The application of the fractal geometry to the dynamics of objects in a space over time generates "complex mechanics", mechanics—which is the change in position of an object in space and time—results from the fractal difference between the constituents of a complex system over time.

Complex mechanics will be explored in Newton's law of gravitation, Coulomb's electrostatic law, atomic binding energies (specifically in the sedimentation of copper-cobalt complexes), and the genetic code, to demonstrate that all these systems generate forces arising from the fractal differences between constituents.

Sony et al. [2] studied the sulfidation of the surface of oxidized ores, where the deposit structure exhibits:

- Surface: Oxides (hematite, goethite, malachite).

- Middle: Mixed minerals, partially transformed oxides and sulfides.

- Bottom: Primary sulfides (chalcopyrite, carrollite).

This study on the sulfidation of the surface of oxidized ores is essential for understanding the processing of these copper and cobalt ores, but also for understanding how nature is structured, based on the fractal differences between the components of the copper-cobalt complex. In this case, the atomic weights, from which the bond energies emerge, allow for the prediction of the sedimentary location and the quantity of each component in the complex.

The closer the molecular weight approaches $+\infty$, the closer the electron dissociation energy approaches 0. This shows that the greater the number of electrons composing a material, the more unstable (easier to dissociate) that material is, and the more it is found towards the center of the system or towards the bottom.

Nucleotides are the fundamental building blocks of DNA and RNA. They are composed of a sugar, a phosphate group, and a nitrogenous base. The five primary nucleotides are named after their nitrogenous base: adenine (A), guanine (G), cytosine (C), and thymine (T) (in DNA), and uracil (U) (in RNA).

Hornos et al. [3] start from the observation that the four nucleotides U, C, A, and G of DNA and U, C, A, and T of RNA can combine into 64 different triplets. However, all living organisms use only 20 different amino acids to build their proteins. The addition of the stop codon implies that there is a total of 21 distinct meanings that can be assigned to the 64 codons, so that several codons can have the same meaning. According to them, this mathematical characteristic is called the degeneracy of the genetic code, although biologists or linguists would probably prefer to speak of "synonymous codons" rather than "degenerate codons."

For them, the notion of degeneracy is deeply linked to that of symmetry. Degeneracy means invariance; in their case, this means that the association of codons with amino acids remains unchanged when the codons are replaced by synonymous codons.

And invariance means symmetry, in the sense that it is possible to construct groups of transformations that preserve certain properties.

They created the evolutionary tree of the genetic code with the amino acid association for the Sp(6) model, based on the symplectic group Sp(6) as the "primordial" symmetry group. In summary, the program works as follows:

- Four nucleotides, considered as input variables, produce one amino acid from three output variables. The number of possibilities is given by 4^3, or 64. This can be considered as a cube with sides of length 4.

- Step 1, each of the 64 possibilities produces a single amino acid.

- Step 2, each of the 64 possibilities produces six amino acids.

- Step 3, each of the 64 possibilities produces thirteen amino acids.

- Step 4, each of the 64 possibilities produces sixteen amino acids.

- Step 5, each of the 64 possibilities produces twenty-one amino acids.

- Step 6, each of the 64 possibilities produces twenty-seven amino acids.

The evolutionary tree of the genetic code of Hornos et al postulates a break in symmetry in its evolution.

This work shows that the evolution of the genetic code can only be accurately interpreted using complex mechanics. The genetic code evolution tree based on group theory can account only till 27 amino acids at the sixtieth step, while the genetic code evolution based on complex mechanics shows the evolution from 4 nucleotides to 4 amino acids up to 4 nucleotides to 64 amino acids in 4 steps.

An emerging or emergent phenomenon is a new, complex property or behavior that arises from the collective interactions of smaller, simpler parts within a system, which the individual parts do not possess on their own. These phenomena are novel, often unpredictable, and emerge as systems become more organized or complex.

Theoretical Framework: Complex Mechanics

Integers are the sum of the fractions of objects smaller than themselves, and so on. An integer at a lower scale can be a fraction at a higher scale, and so on. An atom is an integer at the atomic level, but a fraction at the molecular scale. A human being is an integer at the human scale, but a fraction at the community scale. A political identity is an integer at the scale of political identities, but a fraction at the national scale. A nation is an integer at the national scale, but a fraction at the international scale. A cell is an integer at the cellular level but a fraction at the organ scale and so on.
Various definitions exist in the scientific literature, but for the purposes of this work, a complex system is defined as a set of interconnected and interdependent objects, or a set of entangled objects. A complex system can be both integer in a larger scale and fractional in a smaller scale. It is an integer when it is the sum of the fractions that compose it, and a fraction when it is one of the components of an integer larger than itself. The integer dimension of a complex system depends on the dimensions and the number of fractions of objects that compose it. The fractional dimension of a complex system within a larger complex system is a function of its integer dimension.

This means that the fractional difference propagates from the smallest scale to the largest scale in complex systems.
Therefore, the dynamics of any complex system over time are function of the dynamics of this fractional difference over time.
If the fractional difference between the components of a complex system does not change over time, the complex system is at rest.
If the fractional difference between the components of a complex system decreases over time, the complex system contracts, and if the fractional difference increases, the complex system expands.
It is this fractional difference (difference of potentials) that propagates from the infinitely small to the infinitely large that structures every complex system. A space is defined in this work as a set of objects structured by their fractional differences. Consequently, every space is a special case of a complex system. A complex system in which the fractional difference between its components does not change over time generates a rigid or fixed space in which the scales are integers or rational numbers in time. It is in such a space that Euclydian geometry and orthogonal axes (Cartesian coordinates) apply. The problem with orthogonal axes in a rigid space is that there can only be three (X, Y, Z) at a time. If each axis represents a dimension, a physical (material) space can only have three dimensions. Any rigid object can be considered as a point whose position variation in Cartesian space, formed by three orthogonal axes, can be known at every instant if its initial position and time are known. This dynamic is called deterministic because it is rectilinear. On a line, X = C and C = vt, where v is the velocity and t is the time. On a surface, $Z^2 = X^2 + Y^2$, or $X^2 = (V_1t)^2$, $Y^2 = (V_2t)^2$, and $Z^2 = (V_3t)^2$. $\|Z\|$ or $\|V_3\|=\sqrt{V_1^2 + V_2^2}$. The square root of Z^2 is an integer or rational number if X is a multiple or

submultiple of 3, Y is a multiple or submultiple of 4, and Z is a multiple or submultiple of 5. In all other circumstances, the square root of Z is an irrational number. On a cube $T^3 = X^3 + Y^3 + Z^3$, the cube root of T is an integer or rational number if X is a multiple or submultiple of 3, Y is a multiple or submultiple of 4, Z is a multiple or submultiple of 5, and T is a multiple or submultiple of 6. In all other circumstances, the cube root of T is an irrational number. Hence the limitation of using Cartesian coordinates in the dynamics of complex systems generating spaces of irrational dimension. That is to say, non-symmetric structures, such as spaces of dimension greater than 3. There is no relation $V^n = X^n + Y^n + Z^n + T^n$ where n is greater than 3. It can be concluded that a space of dimension greater than 3 is a non-Cartesian space, it is a space in which the axes are no longer orthogonal, and the dimensions are no longer integers or rational numbers.
A complex system in which the fractional difference between its components changes over time generates a flexible space in which scales are rational or irrational numbers over time.

The dimension of a complex system corresponds to its external size of maximum size.

Each of its constituants represents its internal size or minimum size of a complex system. The root of the complex system.

The relationship between the internal and external sizes of a complex system is given by the number of its fractal dimension that come from the equation: X + C = 0 (1), which gives $X = i^2C$, where i is the imaginary number with a numerical value of -1. Therefore, $i^2 = X/C$ and $i = \sqrt{(X/C)}$. i is a rational or integer if and only if $X = \sqrt{(C)} \times \sqrt{(C)}$ (2). This means the fractal dimension of a complex system becomes irrational if condition (2) is not met. Consequently, the scale of a complex system becomes either rational or irrational.

$i= \sqrt{X/C}$ (3), i=1, if X=1, C=1, i= 2, if X=8, C= 2, i=3, if X=27, C=3. Therefore, $i = (X/\sqrt[C]{C})^C$ (4), where i is the fractal dimension of the complex system or entangled dimension between root (input) and object (output). X is the input variable, and C is the output variable or the dimension of the complex system and i the number of the constituants of a complex system.

A scale is the average distance between constituants of a complex system. Therefore, the fractal scale s= 1/i, what gives $s = ((\sqrt[C]{C})/X))^C$ (5), the fractal scale is the density of probability of presence of a constituant in a complex system or the average distance between constituants of a complex system.

If a a complex system has a 1 constituant, its fractal dimension i = 1 and its fractal scale s=1. If it has 2 constituant for 1 output, its fractal dimension i = 2 and its fractal scale s= 1/2 = 0,5 and so on. The fractal scale correspond to the Schrödinger probability density. The Schrödinger probability density represents the likelihood of finding a particle within a specific region at a given time, where a higher value indicates a higher probability of detection at that location.

The fractal scale represents the magnitude of the fractal difference between the constituents of a complex system, and each magnitude corresponds to a particular emergent phenomenon or a particular emergent force of the interactions between the constituents of a complex system; hence, the concept of emergent force depends on the fractal dimension and the fractal scale of the complex system.

Based on the preceding considerations, a framework capable of studying the evolution of the position of several entangled objects in complex macroscopic/microscopic systems over time has been established through twelve postulates:

Postulate 1: The change in position of the constituents of a complex system over time can only be measured by considering the change in position of the complex system as a whole.

Postulate 2: A complex system can only undergo three movements in space over time: expansion, contraction, and immobility.

Postulate 3: A complex system exhibits deterministic behavior over time if its fractal scale is rigid and its external dimension do not change over time: $\partial C/\partial t = 0$.

Postulate 4: A complex system exhibits probabilistic or quantum behavior over time if its fractal scale is flexible and its external dimensions do change over time: $\partial C/\partial t \neq 0$.

Postulate 5: A complex system contracts over time if $\partial C/\partial t \rightarrow 0$. The complex system tends toward a concave structure or repulsion. The fractal scale of the complex system decreases over time.

$\partial C/\partial t \longrightarrow 0$ corresponds to the increase of competitive dynamics. Increasing in entropy.

Postulate 6: A complex system expands over time if $\partial C/\partial t \rightarrow +\infty$. The complex system tends toward a convex structure or attraction. The fractal scale of the complex system increases over time.

$\partial X/\partial t \longrightarrow +\infty$ corresponds to the increase of cooperative forces dynamics. Decrease in entropy.

Postulate 7: A change in the size of a single constituent of the complex system over time implies a change over time of all its constituents. Non-locality behaviour. Non-locality in probability, particularly in quantum mechanics, refers to scenarios where the outcomes of measurements on separated particles are correlated in ways that cannot be explained by local, pre-existing factors, violating Bell inequalities. These correlations show that physical properties are not solely determined locally, enabling instantaneous connections between all the constituants of a complex system.

Postulate 8: The fractal dimension of a complex system is: $i = (X/\sqrt[C]{C})^C$ (4), where X is the number of input variables and C is the number of output variables. If X is a multiple of C, the ratio i=X/C is an integer or a rational number (symmetric structure or equal distribution over time, linear or deterministic behavior); if X is not a multiple of C, the ratio i=X/C is an irrational number or a fraction or fractal (non-symmetric structure or unequal distribution over time, non-linear or probabilistic behavior).

Postulate 9: The average distance between the components of a complex system, or its scale, is calculated using the formula $s = 1/i$ (5), where i is the fractal dimension of the complex system.

Postulate 10: The position of each constituent within the complex system is: PCn = Sn/ST, where PCn is the position of constituent n, Sn is the dimension of constituent n, and ST is the dimension of the complex system as a whole.

Postulate 11: A complex system can evolve over time from deterministic to probabilistic behavior and viceversa.

Postulate 12: Each fractal scale of a complex system corresponds to a specific emergent behavior (emerging structure), or phase.

From the twelve postulates above, it follows that only two behaviors can emerge from any complex system:

- Deterministic behavior: linear dynamics over time, when the fractal dimension is an integer or a rational number over time. The same behavior is observed after each observation (reproduction). Stability, or energy conservation (low entropy)

- Probabilistic or quantum behavior: nonlinear dynamics over time, when the fractal dimension is an irrational number over time. Different behavior after each observation. Instability, or non conservation of energy (high entropy). It would be important to state that in this work, time does not mean conventional time as measured by a watch, but the number of measurements taken on the complex system by an observer.

These two emergent behaviors of any complex system over time lead to two logical conclusions:

- Deterministic behavior (Newtonian or classical paradigm) is used when a complex system macroscopic/microscopic satisfies postulate 3, the fractal scale do not change over time.
- Probabilistic or quantum behavior (complex or quantum paradigm) emerges from any complex system that satisfies postulate 4, the fractal scale do change over time.
- From the above, it is clear that classical and quantum mechanics are special cases of the complex mechanics.

In this work, a complex system can be a closed or open system. A complex system is an open system if it is a constituants of a larger complex system, it freely exchanges all with its surrounding environment.

A complex system is a closed system if it is not a constituants of a larger complex system, it doesn't have a surrounding environment.

Application of complex mechanics to Newton's law of gravitation and Coulomb's law of electrostatics

Gravitational field.

Given two celestial bodies, each with a mass m_1 for the first celestial body and a mass m_2 for the Newton's gravitational force is calculated using the formula: $F = G(m_1 \times m_2)/d^2$, where d is the distance between the two celestial bodies.

Taking into account postulate 10 of complex mechanics, the position of each component of a complex system is calculated using the formula deducted from the size of the component divided by the maximum size of the complex system: $PC_n = SC_n/TS$, where SC_n is the size of the constituant C_n and TS is the total size of the complex system.Therefore, the position of celestial body 1, $P_1 = m_1/(m_1 + m_2)$, and the position of celestial body 2, $P_2 = m_2/(m_1 + m_2)$, where $m_1 + m_2$ is the total mass of the system.

The distance between the two celestial bodies, or the fractal scale between them, is $s = P_1 - P_2$, which gives $s = (m_1 - m_2) / (m_1 + m_2)$. If $s = 0$, $m_1 = m_2$.

Considering formula (5), $i = 1/s$, i is the fractal dimension of the complex system.

$i = (m_1 + m_2) / (m_1 - m_2)$. If $m_1 = m_2$, the fractal dimension tends towards $+\infty$, meaning that the two bodies repel each other; a repulsive gravitational force emerges between the two celestial bodies.

If m_2 tends towards 0, the fractal dimension tends towards 1, meaning that the two bodies attract each other; an attractive gravitational force emerges between the two celestial bodies.

These above behaviours demonstrate that gravitational attraction or repulsion are emergent phenomena dependent on the fractal difference between the mass of celestial body 1 and the mass of celestial body 2. This leads to the conclusion that gravitational field is structured by the fractal difference in the masses of the constituents of the complex cosmological system. Applying complex mechanics in the complex cosmological system, it appears that gravitational force is an emergent phenomenon and can be both attractive and repulsive. It does not depend on the movement of the supposed particles called gravitons.

Electrostatic field.

All the material or molecules are formed respecting Coulomb law: $F=k(q_1q_2/d^2)$.

Taking into account postulate 10 of complex mechanics, the position of each component of a complex system is calculated using the formula deducted from the size of the component divided by the maximum size of the complex system: $PC_n = SC_n/TS$, where SC_n is the size of the constituant C_n and TS is the total size of the complex system.Therefore, the position of electrical charge 1, $P_1 = q_1/(q_1 + q_2)$, and the position of electrical charge 2, $P_2 = q_2/(q_1 + q_2)$, where $q_1 + q_2$ is the total charge of the system.

The distance between the two electrical charges, or the fractal scale between them, is $s = P_1 - P_2$, which gives $s = (q_1 - q_2) / (q_1 + q_2)$. Considering formula (5), $i = 1/s$, i is the fractal dimension of the complex system.

$i = (q_1 + q_2) / (q_1 - q_2)$. If $q_1 = q_2$, the fractal dimension tends towards $+\infty$, meaning that the two bodies repel each other; a repulsive electrostatic force emerges between the two electrical charges.

If q_2 is the opposite of q_1, the fractal dimension is 0, meaning that the two electrical charges attract each other; an attractive electrostatic force emerges between the two electrical charges.

These above behaviours demonstrate that electrostatic attraction or repulsion are emergent phenomena dependent on the fractal difference between the sign of the electrical charge 1 and the sign of the electrical 2. This leads to the conclusion that the electrostatic field is structured by the fractal difference in the signs of the constituents of the complex electrostatic system.

Applying complex mechanics in complex electrostatic system, it appears that gravitational force is an emergent phenomenon and can be both attractive and repulsive. It does not depend on the movement of the supposed particles called electrons.

Application of complex mechanics to quantum mechanics

To apply complex mechanics to quantum mechanics, which is the mechanics of microscopic complex systems, it is necessary to study atomic bonds and the formation of molecules in materials and classify them according to the bond dissociation energies.

In this work, the case of copper-cobalt complexes is used. The main argument in this work is that atomic bonds are not formed based on an excess or deficit of unpaired electrons in the outer shell of an atom. It is considered that what is called a hole in physics, to which a positive charge is attributed, is the fractal scale of a molecule. Therefore, q_1 and q_2 in this work have the same charge and the same signe $q_1=q_2= e^-$, therefore the more the scale s tends to 0, the more the emerging electrostatic force F is repulsive and unstable, the more the scale s tends to +∞, the more the emerging electrostatic F is less repulsive and stable.

It is assumed that, Coulomb's law, which only applies to the electrostatic interactions between two electrical charges, cannot be applied in a complex electrostatic system involving multiple electrical charges, such as those involved in the formation of atomic or molecular bonds.

Based on the postulates of complex mechanics listed above, the scale of a complex system is the inverse of the fractal dimension of a complex system that is a ratio between the input variables and the output variables. The greater the greater the fractal dimension of a complex system is, the smaller the scale of a complex system is, and therefore the higher the emerging repulsive electrostatic force is. The smaller is the scale of a complex electrostatic system, the lower the molecular bond breaking energy is.

Materials and Methodology

Variables

Electronic Weight (EW): The total number of electrons interacting in the formation of the molecule. EW is the input variable.

Atomic Weight (AW): The total number of atoms forming the molecule. AW is the output variable.

Electron Distance (ED): The ratio between EW and AW or the fractal scale

ED = EW/AW (6) ==> (5): $ED = ((\sqrt[AW]{AW})/(EW))^{AW}$ (7)

The closer ED is to 1, the closer the distance between electrons inside a molecule approaches the maximum distance, the more stable the molecule, and the higher the bond breaking energy. This increases cooperative forces. This means that the structure of the electron distribution becomes symmetrized.

The closer ED is to 0, the closer the distance between electrons in the molecule approaches the minimum distance, the less stable the molecule, and the lower the bond breaking energy. This increases competitive forces. This means that there is a breaking of symmetry in the electron distribution.

Methodology: Comparative

This work compared and established a linear correlation between calculated ED using complex mechanics and the measured Bond Breaking Energy (BBE) values of Cobalt-Oxygen, Copper-Oxygen, Cobalt-Sulfur and Copper-Sulfur.

Results and Discussions

Atomic-Bond	**ED (e/a)**	**BBE (KJ/mol)**
Co-O	**0,001632**	**300 – 380**
Cu-O	**0,001460**	**250 – 320**
Co-S	**0,001081**	**200 – 280**
Cu-S	**0,000987**	**200 – 260**

Table 1: Electron distance and bond breaking energy

Source: Author's calculations based on Michigan State University estimates

Multiplying the ED values in Table 1 with 100000 and considering the maximum value of BBE, generates Figure 1.

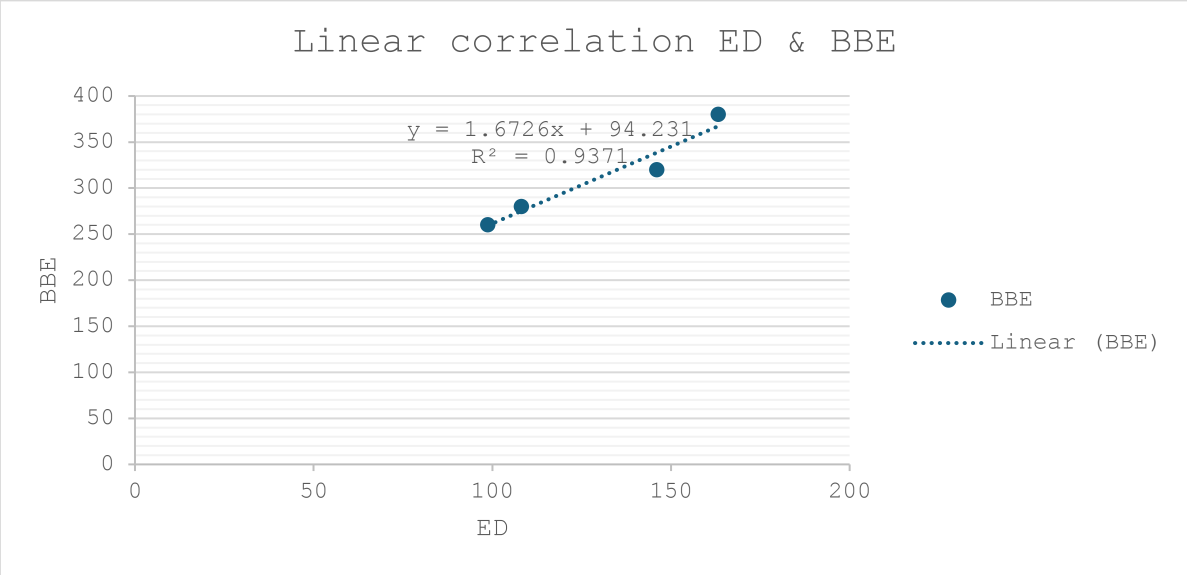

Figure 1: Linear correlation between ED and BBE in Co-O, Cu-O, Co-S and Cu-S bonds

Source: Author from estimates by Organic Chemistry Michigan State University

The correlation coefficient between ED and BBE for Co-O, Cu-O, Co-S, and Cu-S atomic bonds is 97%, and the coefficient of determination is 93%.

The strong linear correlation observed between the values calculated using complex mechanics and the values estimated by organic chemistry at Michigan State University [4], [5] confirms that complex mechanics accurately reflects the dynamics of atomic bonds in the case of copper-cobalt complexes.

Applying complex mechanics to quantum mechanics reveals agreement between the theoretically obtained result and the empirical result presented in work [2], where the constituents of the copper-cobalt complex self-deposit according to their molecular weights:

- On the surface, oxides

- In the middle, a copper-oxygen and cobalt-sulfur mixture

- At the bottom, sulfides

This deposition is consistent with the results in Table 1. The higher the atomic weight, the lower the bond breaking energies, and the more molecular formation requires a high-pressure environment such as the depths of the Earth's crust.

The application of the complex mechanics can be used for the predictability of mineral deposit and optimization of critical minerals with minimal environmental damage. Complex dynamics becomes more deterministic than probabilistic with fractal forecasting.

Application of complex mechanics to genetic code evolution

The work presented in [3] used group theory to reconstruct the evolution of the genetic code in six steps.

This work uses complex mechanics to perform the same reconstruction of the genetic code.

The genetic code is an entanglement of four nucleotides in amino acids, each amino acid being linked to three out of every four nucleotides.

From the perspective of complex mechanics, four nucleotides are considered as input variables and three codons as output variables, representing the dimension of the complex genetic code system. Therefore, the fractal dimension of the complex genetic code system is : $i = (4/\sqrt[3]{3})^3$ = 64/3=21,3333333333333333333333.

The fractal dimension i, correspond to the number of 20 amino acids and a the stop codon:1,3333333333333.

The fractal dimension of the complex genetic code system is not the integer 64, but the fraction 64/3, which corresponds exactly to the number of amino acids appearing in DNA or RNA.

Alternative evolution of the genetic code based on complex mechanics:

- Step 1, input variable 4 and output variable 1, i = 4, 4 amino acids, the scale s = 1/4 = 0,25, all in the same line. The density of probability is 0,25
- Step 2, input variable 4 and the output variable 2, i = 8, 8 amino acids, the scale s = 1/8 =0,125, they are in the same square. The density of probability is 0,125.
- Step 3, input variable 4 and output variable 3, i = 64/3, 21,3333333 amino acids, the scale s = 3/64 =0,0469, they are all in the same cube. The density of probability is 0,0469.

- Step 4, input variable 4 and output variable 4, i = 256/4 = 64 amino acids, the scale s = 1/64 =0,0156, they are all in the same 4-dimension structure, that can not exist in a Cartesian space. The density of probability is 0,0156.

The alternative evolution of the genetic code, based on complex mechanics, follows the same path as the sedimentation of the copper-cobalt complex in the Earth's crust; that is, it conforms to the second law of thermodynamics, namely the increase in entropy in the universe. The higher the temperature, the greater the number of components in the complex system, and the smaller the scale of the complex system.

Conclusion

This work demonstrates that all fields, from gravitational to quantum physics, emerge from the fractal differences between the constituents of a complex system, and not from the motion of particles.

It also shows that complex mechanics can effectively describe the dynamics of microscopic objects, from atomic bonds to the evolution of the genetic code, better than quantum mechanics.

This new physics will contribute significantly to the development of environmental protection, the optimization of artificial intelligence, high-temperature superconducting materials, and quantum computing.

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