RANDOMNESS IS NOT RANDOM: FRACTAL SELF-SIMILAR STABILITY IN THE OBSERVER-DEPENDENT THEORY OF EVERYTHING

(Случайность не случайна: фрактальная самоподобная устойчивость в наблюдатель-зависимой теории всего)

Панкратов Антон Сергеевич
Pankratov Anton Sergeevich

Независимый исследователь, г. Казань, Россия
Independent researcher, Kazan, Russia

E-mail: anton.s.pankratov@gmail.com
ORCID: 0009-0002-4870-2995

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ABSTRACT

A reading of observed randomness as the residual signature of deterministic φ-stability viewed from outside is proposed. Within the formalism of the Observer-Dependent Theory of Everything (ODTOE) [1], the golden ratio φ is the most irrational number in the sense of Greene's residue criterion for the destruction of invariant tori [2, 3]; this endows φ-structured orbits with maximal survival under perturbation. Convergence to a stable configuration Ψ^* is described by a Banach contraction with local contraction modulus $q = \varphi^{-1}$. A transient factor $(\varphi^{-1})^n$ is introduced, coupling the static φ-residue of the corpus [4] to the tail of incomplete convergence: the residue at step n takes the form $\varepsilon(d, n) = (\pi - 3)^2 \varphi^{-|d-d_0|} (\varphi^{-1})^n$. The central thesis is the inversion of the inference arrow: deterministic stability, observed without access to the underlying contraction, presents as apparent randomness. Empirical signatures consistent with this reading are discussed: spectral correlations of random matrices, Benford's law, self-organized criticality. The Hurst relation $H(S) = (1 + S)/2$ is cited as the $S = 0$ special case [5]. A demarcation of statement levels (L1 mathematical fact, L2 physical hypothesis, L3 worldview metaphor) is carried out with stated limits of applicability.

Keywords: randomness, golden ratio, fractal stability, most irrational number, Greene residue criterion, KAM theory, Banach contraction, φ-residue, arrow inversion, ODTOE.

АННОТАЦИЯ

Предложено прочтение наблюдаемой случайности как остаточной сигнатуры детерминированной φ-устойчивости, рассматриваемой извне. В формализме наблюдатель-зависимой теории всего (ODTOE) [1] золотое сечение φ выступает наиболее иррациональным числом в смысле критерия резидуума Грина для разрушения инвариантных торов [2, 3]; это придаёт φ-структурированным орбитам максимальную сохранность при возмущении. Сходимость к устойчивой конфигурации Ψ^* описывается сжимающим отображением Банаха с локальным модулем сжатия $q = \varphi^{-1}$. Введён фактор переходного процесса $(\varphi^{-1})^n$, связывающий статический φ-остаток корпуса [4] с хвостом неполной сходимости: остаток на шаге n принимает вид $\varepsilon(d, n) = (\pi - 3)^2\, \varphi^{-|d-d_0|}\, (\varphi^{-1})^n$. Центральный тезис работы — инверсия стрелки вывода: детерминированная устойчивость, наблюдаемая без доступа к лежащему в основе сжатию, проявляется как видимая случайность. Обсуждены эмпирические сигнатуры, согласующиеся с этим прочтением: спектральные корреляции случайных матриц, закон Бенфорда, самоорганизованная критичность. Хёрстова связь $H(S) = (1 + S)/2$ цитируется как частный случай при $S = 0$ [5]. Проведена демаркация уровней утверждений (L1 математический факт, L2 физическая гипотеза, L3 мировоззренческая метафора).

Ключевые слова: случайность, золотое сечение, фрактальная устойчивость, наиболее иррациональное число, критерий резидуума Грина, КАМ-теория, сжатие Банаха, φ-остаток, инверсия стрелки, ODTOE.

I. INTRODUCTION

The notion of randomness occupies a dual position in the foundations of physics. On one side, randomness is introduced operationally: as the limit of predictability, as the absence of discernible order in a sequence of outcomes. On the other side, those very sequences are generated by fully deterministic systems — iterations of smooth maps, the dynamics of conservative Hamiltonian flows, recurrent arithmetic rules. A classical example is the deterministic nonperiodic flow of Lorenz [6], in which a simple system of differential equations produces trajectories that are observationally indistinguishable from random ones. The paradox is that an observer lacking access to the generating rule registers the product of strict determinism as random.

This work offers a structural analysis of the paradox through the Observer-Dependent Theory of Everything (ODTOE) [1]. The point of departure is Greene's residue criterion [2]: among the irrational numbers, the golden ratio φ has the latest threshold for the destruction of the corresponding invariant torus under perturbation of a Hamiltonian system. This property sets the direction of the whole argument: what appears as the most stable configuration from inside the dynamics yields, when observed from outside, a residue read as apparent randomness.

The work extends the line of [4], in which the golden ratio is established as an invariant of fractal stability, by reversing the inference arrow. Where [4] has the golden ratio organizing fractal stability (the direction $\varphi \to$ stability), here the same machinery is read in reverse: stability, registered by an external observer, presents as apparent randomness (the direction φ-stability $\to$ apparent randomness). The thesis lies in the direction of the arrow; the machinery of φ-stability is taken from the corpus and cited as an established basis, without re-derivation.

The exposition is organized as follows. Section II introduces φ as the most irrational number in the language of Greene's residue criterion. Section III describes convergence to a stable configuration Ψ^* as a Banach contraction with modulus $q = \varphi^{-1}$. Section IV formalizes observed noise as the φ-residue of incomplete convergence and introduces the transient factor. Section V presents the central contribution of the work — the inversion of the inference arrow. Section VI considers empirical signatures consistent with the inverse reading. Section VII carries out the demarcation of statement levels. Section VIII concludes.

II. φ AS THE MOST IRRATIONAL NUMBER

The golden ratio is the positive root of a self-referential equation in which the quantity is expressed through itself:

$$\varphi = 1 + \frac{1}{\varphi}, \qquad \varphi = \frac{1+\sqrt{5}}{2}. \tag{1}$$

Relation (1) admits a continued-fraction form in which all partial quotients equal unity:

$$\varphi = [1;\, 1,\, 1,\, 1,\, \ldots]. \tag{2}$$

The form (2) is a mathematical fact; its meaning for stability is disclosed, however, through Greene's residue criterion for invariant tori [2], over and above the rate of rational approximation taken on its own. Greene [2] established a working criterion for the destruction of a quasiperiodic trajectory with a given rotation number: the torus survives as long as the residue R of the associated periodic orbits remains below a threshold; crossing the threshold marks the transition to chaotic dynamics. Indexing the orbits by the rational approximants converging to the rotation number yields a sequence of residues whose behavior fixes the moment of destruction.

For a rotation number equal to the golden ratio, the residue sequence reaches the critical threshold later than for any other irrational number: the torus with golden rotation number is the last to be destroyed as the perturbation grows. In this sense φ is the most irrational number — the one whose quasiperiodic orbits resist resonant destruction most strongly. Greene's criterion was subsequently placed within the rigorous framework of Kolmogorov–Arnold–Moser theory [3], which establishes the survival of sufficiently irrational tori under small perturbation, and modern results in weak KAM theory and Aubry–Mather theory [7] refine the structure of the surviving invariant sets near the critical threshold.

Within ODTOE [1] this property of φ receives a direct interpretation: φ-structured configurations of the self-observation loop retain stability against resonant destruction longer than others. The line of [4] develops this stability in the direction $\varphi \to$ fractal organization; here Greene's criterion serves as the entry point for the reverse reading (Section V). Epistemic status: the most-irrationality of φ and the form (2) are mathematical facts (L1); the interpretation of φ-stability as the persistence of an observation configuration belongs to the level of physical hypothesis (L2). Objections to over-interpreting the presence of φ in natural systems are taken up in Section VII with reference to the critical analysis [8].

III. CONVERGENCE TO A STABLE CONFIGURATION Ψ^*

The stable observation configuration Ψ^* is defined in the ODTOE corpus as the fixed point of the self-observation operator Φ:

$$\Psi^* = \Phi(\Psi^*). \tag{3}$$

The existence and uniqueness of Ψ^* in the sense of (3) are established in [9, 10] via the Banach fixed-point theorem and are taken here as an established basis; the proof is not reproduced. What concerns us is the rate of approach to the fixed point, taken apart from the question of its existence, since it is the incompleteness of convergence that generates the observed residue (Section IV).

Let $\Delta_n = \|\Psi_n - \Psi^*\|$ denote the residual distance from the current field Ψ_n to the fixed point after n iterations of the operator Φ. For a contraction with modulus $q < 1$, the Banach theorem yields a geometric bound on the decay of the residual:

$$\Delta_n \leq q^n \, \Delta_0, \qquad q = \varphi^{-1}. \tag{4}$$

The value of the modulus $q = \varphi^{-1}$ follows from the spectral argument for the linearization of the operator Φ near the fixed point [9, 11]: the derivative of the generating self-referential map at the point φ fixes the local contraction rate, identified with φ^{-1}. Numerically,

$$q = \varphi^{-1} = 0.61803398874989484820458683436563811772030917980576$$

to 50 significant digits.

Here φ^{-1} serves solely as the local contraction modulus in a neighborhood of the fixed point and is identified with no empirically minimizing value of any parameter; the question of the minimum of a coherence-related quantity is discussed separately in Section IV as a hypothesis. Epistemic status: the Banach theorem and the bound (4) are mathematical facts (L1); the identification of q with the convergence rate of the physical observation loop belongs to the level of hypothesis (L2). We note that (4) describes convergence within a single level of recursion; inter-level scaling is introduced in Section IV.

IV. NOISE AS THE φ-RESIDUE OF INCOMPLETE CONVERGENCE

The construction central to the formal level of the work links observed noise to the residual that an iteration converging to Ψ^* leaves at each step. The ODTOE corpus establishes that inter-level connectivity decays by a φ-law. The entanglement entropy of a level scales as

$$S_{\text{ent}}(\rho_d) \propto \varphi^{-|\Delta d|}, \tag{5}$$

where $|\Delta d| = |d - d_0|$ is the distance in recursion levels from the observer level d_0. Relation (5) is established in [4] and is cited here as an established signature of φ-fractality, without re-derivation; it describes the static part of the residual, independent of the iteration index.

To the static φ-residue the work adds a transient factor. If the residual at the observer level carries the irreducible spiral gap $(\pi - 3)^2$ [1, 12], scaled across levels by the factor $\varphi^{-|\Delta d|}$ of (5), while convergence within a level obeys the Banach bound (4) with modulus φ^{-1}, then the residual after n iterations at level d takes the form

$$\varepsilon(d, n) = (\pi - 3)^2 \, \varphi^{-|d-d_0|} \, (\varphi^{-1})^n. \tag{6}$$

In expression (6) the static factor $(\pi - 3)^2 \, \varphi^{-|d-d_0|}$ is the φ-fractality signature of the corpus [4, 13], whereas the transient factor $(\varphi^{-1})^n$ is the contribution of the present work: it couples the static residual to the tail of incomplete convergence of the observation loop. The line of [13] describes the φ-scaling of the spiral gap across levels and the contraction of the gap under iteration toward Ψ^*; the present work takes the same residual as an object of external observation and links it to apparent randomness (Section V). The multifractal structure of the residual in developed turbulence [14] gives an independent example of the coupling of a static self-similar signature to scale intermittency, akin to the form (6) proposed here. The numerical value of the spiral gap

$$(\pi - 3)^2 = 0.020048479550599188058630700199133830130683010990156$$

is given to 50 significant digits.

The factor $(\varphi^{-1})^n$ decreases monotonically: at $n = 0$ the residual carries the full static gap, at $n = 1$ the residual is $\varphi^{-1} \approx 0.618$ of it, at $n = 5$ about $\varphi^{-5} \approx 0.090$. The residual tends to zero as $n \to \infty$ while staying positive for any finite n: full closure of the loop is unattainable [1], and it is this irreducible positivity of the residual that feeds the observed variability.

The link between the contraction modulus q and coherence calls for a separate caveat. If coherence S and the related quantity B are described by a joint dependence $q(B, S)$, then the minimum of this dependence is attained, presumably, near $q \approx 0.678$ at $B = S \approx 0.562$; this numerical value has the status of a hypothesis and is kept apart from the local contraction modulus φ^{-1}, with which it does not coincide. Identifying the minimum with φ^{-1} would be a methodologically incorrect fit. Therefore φ^{-1} is held strictly as the local contraction modulus (4), while the claim about the minimum of $q(B, S)$ is marked as a hypothesis and is not used further in the conclusions. Epistemic status: the values of $(\pi - 3)^2$ and the φ-decay are mathematical facts (L1); the interpretation of $\varepsilon(d, n)$ as observed noise belongs to the level of physical hypothesis (L2); the hypothesis about the minimum of $q(B, S)$ is explicitly marked and set aside from the derived consequences.

V. INVERSION OF THE INFERENCE ARROW

The preceding sections reproduce the machinery of φ-stability in the terms of the corpus: Greene's residue criterion (Section II), the Banach contraction (Section III), the residual with a transient factor (Section IV). The distinctive contribution of the present work lies in a single move that no work of the corpus makes: the reversal of the inference arrow between stability and randomness.

Consider an observer registering the behavior of a system that converges to a stable configuration Ψ^* by the deterministic law (4). If the observer has access to the generating rule — to the operator Φ and the contraction modulus φ^{-1} — they see an ordered geometric convergence. If access to the generating rule is absent, the observer has available only the sequence of residuals $\varepsilon(d, n)$ (6), registered at various levels d and steps n without knowledge of the indices. This sequence, stripped of its generating rule, is indistinguishable from a sample of a random process: it shows no discernible periodicity (the rotation number φ is the most irrational, Section II), its amplitude is distributed by a φ-law, and its correlation structure is set by the fractal self-similarity of the levels.

Hence the central thesis: deterministic φ-stability, observed from outside, without access to the underlying contraction, presents as apparent randomness. The inference arrow reverses. In the forward reading of the corpus [4] the golden ratio generates fractal stability; in the reverse reading the same stability, once registered by an external observer, appears as randomness. Apparent randomness is thus an epistemic effect of the observer's limited access to the generating dynamics; ontologically the system remains deterministic.

The substance of the thesis comes precisely from reversing the arrow of φ-stability, where for an arbitrary deterministic dynamics the same move would be less telling. An arbitrary deterministic orbit, observed from outside, could reveal periodicity or a resonant structure that betrays the generating rule. An orbit with golden rotation number reveals no such structure: its most-irrationality (Section II) is exactly the property that makes its external registration maximally similar to a random one. The most stable configuration turns out to be also the most indistinguishable from random under external observation. The origin of the observer and the meaning of the qualifier "from outside" are developed in [15]; here it suffices to record that the boundary of the observer's access to the generating rule is the surface on which stability passes into the appearance of randomness [1].

The epistemic status of the thesis calls for precise marking, since the risk of conflating a structural description with a worldview claim is highest exactly here.

The arrow inversion as a statement about a model of stability is a hypothesis of level L2: it formulates a testable relation between the observer's access and the registered statistics. The statement "randomness is not random" as a worldview thesis belongs to level L3 (metaphor, worldview) and is marked as such explicitly: it serves as an interpretive frame open to revision and has no status of a theorem derivable from L1 facts and L2 hypotheses. The partition of levels is carried out in Section VII.

VI. EMPIRICAL SIGNATURES

The inverse reading of Section V admits comparison with a range of empirical signatures in which deterministic structure is registered as a statistical regularity. The signatures are given qualitatively and as consistent with the inverse interpretation, without a claim of proof; quantitative results are cited from primary sources.

Spectral correlations of random matrices give the first signature. The Bohigas–Giannoni–Schmit conjecture [16] links the level statistics of quantum systems whose classical limit is chaotic to Wigner random-matrix ensembles [17]: deterministic dynamics generates a spectrum whose local statistics are indistinguishable from the random-matrix one. Modern results on the Sachdev–Ye–Kitaev model [18] and on random-matrix universality [19] confirm the robustness of this link. In the terms of the inverse reading, spectral rigidity is a signature of deterministic stability read as randomness: level repulsion reflects a resistance to resonant degeneracy akin to the most-irrationality of Section II. This connection of self-similarity with spectral statistics is noted in [4] as well; here it is presented as consistent with the inverse interpretation, at the level of a restatement of what is already known.

Benford's law gives the second signature. The distribution of leading significant digits of quantities spanning many orders of magnitude follows a logarithmic law [12]: deterministic multiplicative processes generate statistics that look random yet are strictly prescribed by scale invariance. In the inverse reading the Benford distribution is a signature of scale-self-similar stability registered as apparent randomness of digit distribution; the same scale invariance is discussed in [4].

Self-organized criticality gives the third signature. The Bak–Tang–Wiesenfeld model [20] shows that dissipative systems spontaneously evolve toward a critical state with a power-law distribution of event sizes. Modern reviews of self-organized criticality in astrophysical and laboratory systems [21, 22] confirm the ubiquity of power-law structure. In the inverse reading the power-law tail is a signature of self-similar stability near the critical threshold, read as randomness of avalanche sizes; a related fractal organization is described in [23]. The claim of power-law structure, however, calls for caution: the critical analysis [24] shows that a power law is often asserted on insufficient data, and the methodological analysis [25] sets strict criteria for distinguishing a power-law tail from a log-normal or an exponential one. Power-law signatures are therefore given here at the level of qualitative consistency, without a claim of quantitative establishment.

Stochastic resonance gives a further signature: the addition of noise to a nonlinear system can enhance the response to a weak deterministic signal [26], which in the inverse reading reads as the mutual passability of the deterministic and random components at the boundary of the observer's access. Modern data on fractional Brownian motion with a random Hurst exponent [27] show that the self-similarity exponent itself may vary along a trajectory, consistent with the level-dependent structure of the residual (6).

Finally, the fractal structure of Brownian trajectories joins the present reading through one connection of the corpus. The Hurst exponent of fractional Brownian motion is related to coherence by $H(S) = (1 + S)/2$; classical Brownian motion with $H = 1/2$ is the $S = 0$ special case of the same surface [5]. This relation is cited as an established result and is not derived here:

$$H(S) = \frac{1 + S}{2}. \tag{7}$$

Relation (7) enters the present work solely as a citation and links the fractal dimension of the Brownian trajectory to coherence S through the corpus result [5]. Epistemic status of the signatures: the experimental and numerical results [12, 16, 17, 18, 20, 21, 22, 26, 27] are established facts (L1) within their primary sources; their interpretation as signatures of the inverse reading belongs to the level of physical hypothesis (L2) and is given as consistency.

VII. DEMARCATION

The discipline of provenance requires an explicit partition of the work's claims across three epistemic levels [1].

Level L1 (mathematical facts) comprises: the most-irrationality of φ and the continued-fraction form (2); the fixed-point equation (1); the Banach theorem and the geometric convergence bound (4); the numerical values of φ^{-1} and $(\pi - 3)^2$ to 50 significant digits; the monotone φ-decay of the factors. These claims are independent of the ODTOE formalism and are verifiable by the methods of analysis and number theory.

Level L2 (physical hypotheses) comprises: the interpretation of φ-stability as the persistence of an observation configuration (Section II); the identification of the contraction modulus $q = \varphi^{-1}$ with the convergence rate of the observation loop (Section III); the interpretation of the residual $\varepsilon(d, n)$ (6) as observed noise, including the transient factor (Section IV); the arrow inversion as a relation between the observer's access and the registered statistics (Section V); the comparison with empirical signatures (Section VI). These claims formulate testable relations and are open to independent verification.

Level L3 (worldview metaphor) comprises the worldview thesis ”randomness is not random” and the interpretation of the golden ratio as a ”code of nature.” These readings are at the level of metaphor: they serve as an interpretive frame and are held apart from the L1 facts and the L2 hypotheses, with no status of theorems. The work explicitly separates the strong L3 reading from the scientific content and assigns it no demonstrative status.

Two classes of assertions call for a separate caveat. First, claims about the presence of the golden ratio in natural systems are historically prone to over-interpretation; the critical analysis [8] shows that many such claims do not survive quantitative testing. The φ-structure is therefore held in the present work at the level of a property of the stability dynamics (L2), apart from a treatment as a universal ornament of nature (L3). Second, claims about the power-law structure of empirical distributions require strict statistical testing [24, 25]; the power-law signatures of Section VI are given at the level of qualitative consistency, without a claim of quantitative establishment. Finally, the hypothesis about the minimum of the coherence-related quantity $q(B, S)$ (Section IV) is explicitly marked as a conjecture and is not used in the conclusions: the numerical value of the minimum is kept apart from the local contraction modulus φ^{-1}.

VIII. CONCLUSION

The work proposes a reading of observed randomness as the residual signature of deterministic φ-stability registered from outside. The golden ratio is introduced as the most irrational number in the language of Greene's residue criterion [2, 3], which endows φ-structured orbits with maximal survival under perturbation. Convergence to a stable configuration Ψ^* is described as a Banach contraction with local modulus $q = \varphi^{-1}$ (4). Observed noise is formalized as the φ-residue of incomplete convergence $\varepsilon(d, n) = (\pi - 3)^2 \varphi^{-|d-d_0|} (\varphi^{-1})^n$ (6), in which the static factor is cited from the corpus [4, 13] while the transient factor $(\varphi^{-1})^n$ is the contribution of the present work. The central contribution is the inversion of the inference arrow: deterministic stability, observed without access to the generating contraction, presents as apparent randomness (Section V). The signatures of random-matrix statistics, Benford's law, and self-organized criticality are given as consistent with the inverse reading; the Hurst relation $H(S) = (1 + S)/2$ is cited as the $S = 0$ special case [5]. A partition of statement levels is carried out, with the worldview thesis marked explicitly as a metaphor (L3) and with stated limits of applicability. The work is presented as an extension of the line of [4] through the reversal of the inference arrow, without rediscovering the machinery of φ-stability.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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ODTOE Corpus Navigation

Full corpus of the author's articles: odtoe.org/en/articles.

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