Consistent Cosmology, Causal Relativity, and Quantized Gravity as Intrinsically Unified Manifestations of the Symmetry of Complexity

Unified Dynamic Symmetry Paradigm

THE CONSTRUCTIVE POWER OF INTERACTION-DRIVEN CHAOS IN WORLD STRUCTURE CREATION AND DYNAMICS

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The universal symmetry, or conservation, of complexity underlies any law or principle of system dynamics and describes the unceasing transformation of dynamic information into dynamic entropy as the unique way to conserve their sum, the total dynamic complexity [1-7].

Here we describe the real world structure emergence and dynamics as a result of the universal symmetry of complexity of interaction between two initially homogeneous protofields. It provides the unified complex-dynamic, causally complete origin of physically real, 3D space, time, elementary particles, their properties (mass, charge, spin, etc.), quantum, relativistic, and classical behaviour, as well as fundamental interaction forces, including naturally quantized gravitation. The old and new cosmological problems (including "dark" mass and energy) are basically solved for this explicitly emerging, permanently changing world structure characterised by strictly positive (and large) complexity-energy [4].

The unified, causally explained quantum, classical, and relativistic properties (and types of behaviour) are generalised to all higher levels of complex world dynamics. The real world structure, dynamics, and evolution are exactly reproduced by the probabilistic dynamical fractal, which is obtained as the truly complete general solution of a problem and the unique structure of the new mathematics of complexity [1,12].

We outline particular applications of always exact, but irregularly structured symmetry of unreduced dynamic complexity [1,2] to microworld dynamics, including particle physics [5,6], genuine quantum chaos [7-10], real nanobiotechnology [7,8], and reliable genomics [7,12].

UNIVERSAL SYMMETRY OF COMPLEXITY
SOLVES REAL-WORLD PROBLEMS

SCHEME OF COMPLEX-DYNAMICAL UNIVERSE STRUCTURE:

two attracting, omnipresent protofields give rise to all particles and fields, their intrinsic properties, unified quantum and relativistic behaviour

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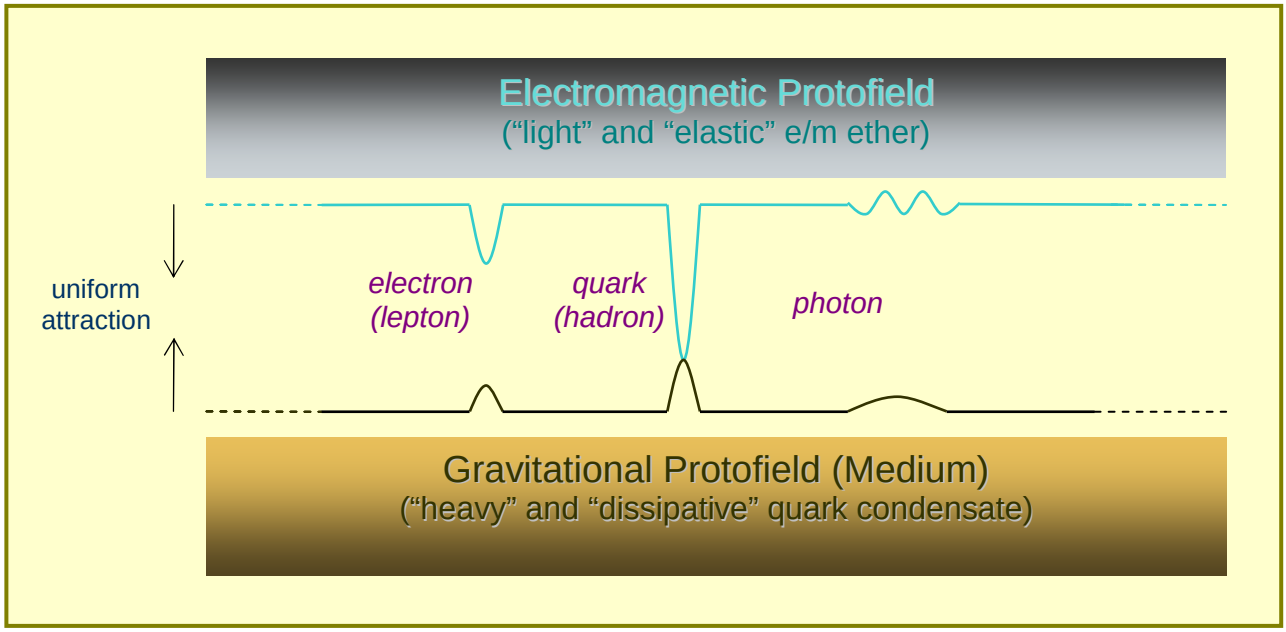
QUANTUM FIELD MECHANICS

↓ CONFIRMED BY RECENT "QUARK LIQUID" EXPERIMENT RESULTS ↓



Unreduced interaction gives inhomogeneous, changing and chaotic structure emergence (elementary particles) in the initially homogeneous, simplest system [1-7]:

$$\left[h_{\rm g}(\xi)+V(\xi,q)+h_{\rm e}(q)\right]\Psi(\xi,q)=E\Psi(\xi,q) \qquad (1)$$

In terms of internal degrees of freedom of e/m protofield:

$$\Psi(\xi,q)=\sum_n \psi_n(\xi)\varphi_n(q)\ ,\quad h_{\rm e}(q)\varphi_n(q)=\varepsilon_n\varphi_n(q) \qquad (2a)$$

$$\left[h_{\rm g}(\xi)+V_{nn}(\xi)\right]\psi_n(\xi)+\sum_{n'\neq n}V_{nn'}(\xi)\psi_{n'}(\xi)=\eta_n\psi_n(\xi) \qquad (2b)$$

$$V_{nn'}(\xi)=\int_{\Omega_q} dq\phi_n^*(q)V_{\rm eg}(q,\xi)\phi_{n'}(q)\ ,\quad \eta_n=E-\varepsilon_n \qquad (2c)$$

Instead of usual perturbative approximation,

$$\left[h_{\rm g}(\xi)+V_{nn}(\xi)+\tilde V_n(\xi)\right]\psi_n(\xi)=\eta_n\psi_n(\xi)\ ,\quad \left|V_0(\xi)\right|\le\left|\tilde V_n(\xi)\right|\le\left|\sum_{n'}V_{nn'}(\xi)\right| \qquad (3)$$

we get the dynamically probabilistic sum of redundant system realisations:

$$\rho(\xi,q)\equiv\left|\Psi(\xi,q)\right|^2=\sum_{r=1}^{N_{\Re}}{}^{\oplus}\rho_r(\xi,q),\ \ \alpha_r=\mathrm{prob}\left[\rho_r(\xi,q)\right]=\frac{1}{N_{\Re}},\ \ \rho_r(\xi,q)=\left|\Psi_r(\xi,q)\right|^2 \qquad (4)$$

$$\Psi_r(\xi,q)=\sum_i c_i^r\left[\varphi_0(q)\psi_{0i}^r(\xi)+\sum_{n,i'}\frac{\varphi_n(q)\psi_{ni'}^0(\xi)\int_{\Omega_\xi}d\xi'\psi_{ni'}^{0*}(\xi')V_{n0}(\xi')\psi_{0i}^r(\xi')}{\eta_i^r-\eta_{ni'}^0-\varepsilon_{n0}}\right] \quad (5)$$

where $\{\psi_{0i}^r(\xi),\eta_i^r\}$ are eigen-solutions of the effective potential (EP) equation:

$$h_g(\xi)\psi_0(\xi)+V_{\text{eff}}(\xi;\eta)\psi_0(\xi)=\eta\psi_0(\xi) \quad (6)$$

$$V_{\text{eff}}(\xi;\eta_i^r)\psi_{0i}^r(\xi)=V_{00}(\xi)\psi_{0i}^r(\xi)+\sum_{n,i'}\frac{V_{0n}(\xi)\psi_{ni'}^0(\xi)\int_{\Omega_\xi}d\xi'\psi_{ni'}^{0*}(\xi')V_{n0}(\xi')\psi_{0i}^r(\xi')}{\eta_i^r-\eta_{ni'}^0-\varepsilon_{n0}} \quad (7)$$

and $\{\psi_{ni}^0(\xi),\eta_{ni}^0\}$ are eigen-solutions of a truncated system of equations:

$$\left[h_g(\xi)+V_{nn}(\xi)\right]\psi_n(\xi)+\sum_{n'\neq n}V_{nn'}(\xi)\psi_{n'}(\xi)=\eta_n\psi_n(\xi)\ ,\quad n\neq 0 \quad (8)$$

Emerging elements of space $\Delta x=\lambda_C=\Delta_r\eta_i^r$, time $\Delta t=\Delta x/c$, and action $\mathcal{A}_0=h=|V_{\text{eff}}|\Delta t$ (9)

Dynamic complexity C is universally defined as a growing function of realisation number $N_{\Re}$, or rate of their change, equal to zero for $N_{\Re}=1$: $C=C(N_{\Re})$, $dC/dN_{\Re}>0$, $C(1)=0$

COMPLEX-DYNAMICAL FRACTAL AS THE GENERAL SOLUTION OF A PROBLEM

System of auxiliary (truncated) equations (8) is replaced by its effective version:

$$\left[h_0(\xi)+V_{\text{eff}}^n(\xi;\eta_n)\right]\psi_n(\xi)=\eta_n\psi_n(\xi) \quad (10)$$

$$V_{\text{eff}}^n(\xi;\eta_n)\psi_n(\xi)=V_{nn}(\xi)\psi_n(\xi)+\sum_{n'\neq n,\,i}\frac{V_{nn'}(\xi)\psi_{n'i}^{0n}(\xi)\int_{\Omega_\xi}d\xi'\psi_{n'i}^{0n*}(\xi')V_{n'n}(\xi')\psi_n(\xi')}{\eta_n-\eta_{n'i}^{0n}+\varepsilon_{n0}-\varepsilon_{n'0}} \quad (11)$$

where $\{\psi_{n'i}^{0n}(\xi),\eta_{n'i}^{0n}\}$ are eigen-solutions of a further truncated system of equations:

$$h_0(\xi)\psi_{n'}(\xi)+\sum_{n''\neq n'}V_{n'n''}(\xi)\psi_{n''}(\xi)=\eta_{n'}\psi_{n'}(\xi)\ ,\quad n'\neq n\ ,\quad n,n'\neq 0 \quad (12)$$

Dynamic multivaluedness of solutions of eqs. (10)-(11):

$$\{\psi_{ni}^0(\xi),\eta_{ni}^0\}\rightarrow\{\psi_{ni}^{0r'}(\xi),\eta_{ni}^{0r'}\} \quad (13)$$

$$\Downarrow$$

Dynamical, probabilistic fractal as the truly complete general solution [1,12]:

$$\rho(\xi,Q)=\sum_{r,r',\ldots}^{N_{\Re}}{}^{\oplus}\rho_{rr'\ldots}(\xi,Q)\ ,\quad \rho_{\exp}(\xi,Q)=\sum_{r,r',\ldots}^{N_{\Re}}\alpha_{rr'\ldots}\rho_{rr'\ldots}(\xi,Q)\ ,\quad \alpha_{rr'\ldots}=\text{prob}[\rho_{rr'\ldots}]=\frac{N_{rr'\ldots}}{N_{\Re}} \quad (14)$$

ELEMENTARY PARTICLE AS A SPATIALLY CHAOTIC QUANTUM BEAT PROCESS

Unreduced protofield interaction gives spatially chaotic (dynamically multivalued), time-periodic local pulsation, or quantum beat = elementary (massive) field-particle

Action as a universal (integral) complexity measure (of emerging structure) [1-7]:

$$\Delta\mathcal{A} = -E\Delta t + p\Delta x \qquad (15)$$

Elementary field-particle at rest (= minimum complexity-energy):

$$E_0 = -\frac{\Delta\mathcal{A}}{\Delta t} = \frac{h}{\tau_0} = h\nu_0 \qquad (16)$$

where $\Delta\mathcal{A} = -h$ for one quantum jump and $\nu_0 \equiv 1/\tau_0$ is the quantum beat frequency ($\nu_0 \sim 10^{20}$ Hz for the electron) → complex-dynamic origin of irreversible time flow

Universal inertia and mass result from derived spatial chaoticity of quantum beat:

$$m_0c^2 = h\nu_0 \qquad (17)$$

→ no need for additional entities (Higgs, zero-point fields, etc.) "providing" mass

Global field-particle motion rigorously defined as increased complexity-energy [1-7]:

$$\frac{\Delta\mathcal{A}}{\Delta t} = \frac{\Delta\mathcal{A}}{\Delta t}\Big|_{x=\text{const}} + \frac{\Delta\mathcal{A}}{\Delta x}\Big|_{t=\text{const}}\frac{\Delta x}{\Delta t}\ , \quad E = -\frac{\Delta\mathcal{A}}{\Delta t} + \frac{\Delta\mathcal{A}}{\lambda}\frac{\Delta x}{\Delta t} = \frac{h}{T} + \frac{h}{\lambda}v = hN + pv \qquad (18)$$

Universally defined total energy-complexity: $E = -\frac{\Delta\mathcal{A}}{\Delta t}\Big|_{x=\text{const}} = \frac{h}{\tau} = h\nu$ (19)

Universally defined momentum-complexity: $p = \frac{\Delta\mathcal{A}}{\Delta x}\Big|_{t=\text{const}} = \frac{\Delta\mathcal{A}}{\lambda} = \frac{h}{\lambda}$ (20)

Dynamic "quantum of space" or de Broglie wavelength (now causally derived):

$$\lambda \equiv \lambda_B \equiv (\Delta x)|_{t=\text{const}} = \frac{h}{p} \qquad (21)$$

INTRINSIC UNIFICATION OF CAUSAL QUANTUM AND RELATIVISTIC DYNAMICS

"Relativistic" dispersion relation expresses chaotic wandering within field-particle [5,6]:

$$p = E\frac{v}{c^2} = mv \qquad (22)$$

where $m \equiv E/c^2$, now by rigorously substantiated definition

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Relativity, Newton's laws are causally derived as unreduced complexity manifestations

Using relations (22) and (19) in eq. (18), we get dynamically derived time relativity:

$$\tau = T\left(1 - \frac{v^2}{c^2}\right)\ , \quad T\tau = (\tau_0)^2\ , \quad T = \frac{\tau_0}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{or} \quad N = \nu_0\sqrt{1 - \frac{v^2}{c^2}} \qquad (23)$$

Relativistic/quantum effects are due to complex (multivalued) dynamics within each particle

COMPLEX-DYNAMIC ORIGIN OF QUANTIZED GRAVITY AND GENERAL RELATIVITY

Quantum beat dynamics as causal origin of quantized gravity and general relativity [1,5,6]:

$$h\nu_0(x) = m_0c^2\sqrt{g_{00}(x)}\ , \quad g_{00}(x) = 1 + 2\phi_g(x)/c^2 \qquad (24)$$

where $g_{00}(x)$ is the (relative) tension/density of gravitational medium (protofield) and $\phi_g(x)$ is the classical gravitational field potential

Since $\phi_g(x) < 0$ (attraction), $\nu_0(x) < \nu_0 = m_0c^2/h$ → causal time retardation in gravity field

DYNAMIC QUANTIZATION AND CAUSALLY DERIVED WAVE EQUATIONS

Natural quantization of quantum beat (realisation change) by conservation of complexity [1-7]:

$$\Delta(\mathcal{A}\Psi) = \mathcal{A}\Delta\Psi + \Psi\Delta\mathcal{A} = 0\ , \quad \Delta\mathcal{A} = -\mathcal{A}_0\frac{\Delta\Psi}{\Psi} = -\mathrm{i}\hbar\frac{\Delta\Psi}{\Psi} \qquad (25)$$

Causal, realistic meaning of the wavefunction Ψ as quasi-free protofield state during chaotic transitions between dynamically squeezed, "corpuscular" states

Inserting (25) into universal definitions of energy (19) and momentum (20) one obtains causally derived version of Dirac quantization:

$$E = -\frac{\Delta\mathcal{A}}{\Delta t}\Big|_{x=\mathrm{const}} = \frac{1}{\Psi}\mathrm{i}\hbar\frac{\partial\Psi}{\partial t}\ , \quad p = \frac{\Delta\mathcal{A}}{\Delta x}\Big|_{t=\mathrm{const}} = -\frac{1}{\Psi}\mathrm{i}\hbar\frac{\partial\Psi}{\partial x}\ , \quad p^2 = -\frac{1}{\Psi}\hbar^2\frac{\partial^2\Psi}{\partial x^2}\ , \quad E^2 = -\frac{1}{\Psi}\hbar^2\frac{\partial^2\Psi}{\partial t^2} \qquad (26)$$

Causal quantization relations are inserted into eq. (18) using eq. (23),

$$E = m_0c^2\sqrt{1-\frac{v^2}{c^2}} + \frac{p^2}{m} \quad \text{or} \quad mE = m_0c^2 + p^2 \qquad (18')$$

which gives relativistic wave equations (Klein-Gordon, Dirac):

$$\mathrm{i}\hbar m\frac{\partial\Psi}{\partial t} + \hbar^2\frac{\partial^2\Psi}{\partial x^2} - m_0^2c^2\Psi = 0\ , \quad \frac{\partial^2\Psi}{\partial t^2} - c^2\frac{\partial^2\Psi}{\partial x^2} + \omega_0^2\Psi = 0\ , \quad \omega_0 \equiv m_0c^2/\hbar = 2\pi\nu_0 \qquad (27)$$

Causally derived Schrödinger equation (using eq. (26)):

$$E = \frac{p^2}{2m_0} + V(x,t) \quad \Rightarrow \quad \mathrm{i}\hbar\frac{\partial\Psi}{\partial t} = -\frac{\hbar^2}{2m_0}\frac{\partial^2\Psi}{\partial x^2} + V(x,t)\Psi(x,t) \qquad (28)$$

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Complex-dynamic origin of "energy level discreteness"

DYNAMICALLY EXPLAINED (EMERGING) PROPERTIES OF THE UNIVERSE STRUCTURE [1-12]

- Dynamic, realistic origin of material, quantized space and irreversibly flowing time
  Origin and number (3) of space dimensions, universality (synchronisation) of time flow
- Physically real, "minimal", universal origin of particles/fields and all their properties
  Unified causal (dynamic) explanation of relativistic and quantum properties, mass, charge, spin
- Combination of global universality and local features (time, space, wavefunction, etc.)
  Origin of universal constants (below), interactions, time flow, individual particle properties
- Causal origin and number (4) of intrinsically unified particle interactions
- Dynamic origin of classicality (in a closed system) and other higher-complexity cases
  Causal quantum measurement, wave reduction, true quantum chaos, many-body problems, etc.

UNIVERSALITY AND MEANING OF PLANCK AND FINE STRUCTURE CONSTANTS

$$\alpha\hbar = \frac{e^2}{c} \quad \Rightarrow \quad m_0c^2 = \frac{2\pi}{\alpha}\frac{e^2}{\lambda_C} = N^e_{\Re}\frac{e^2}{\lambda_C} \tag{29}$$

$\lambda_C = \dfrac{h}{m_0c^2}$, $N^e_{\Re} = 2\pi/\alpha \approx 861$ is the number of electron (quantum beat) realisations

$$\lambda_C = \frac{h}{m_0c^2} = N^e_{\Re} r_e, \quad \text{where } r_e = \frac{e^2}{m_0c^2} \text{ is the "classical electron radius"} \tag{30}$$

$\Downarrow$

Size of the dynamically squeezed electron state ("virtual soliton") $D_e \simeq 2\pi r_e = \pi d_e$ (31)

Universal meaning of Planck's constant h and fine structure constant α:

$$h = \lambda_C p_e = N^e_{\Re}\frac{e^2}{c}, \quad p_e = m_0c = E_0/c \tag{32a}$$

$\lambda_C = N^e_{\Re} r_e$, $N^e_{\Re} = 2\pi/\alpha$ is the width of EP well for a field-particle (e.g. electron) (32b)

$p_e = m_0c$, $e^2/c = \alpha\hbar$ is the depth of EP well for a field-particle (e.g. electron) (32c)

$h = \lambda_C p_e = N^e_{\Re}\dfrac{e^2}{c}$ is the universal "volume" of EP well for any field-particle (32d)

Additional confirmation: largest nuclear mass ≈ largest particle mass (≈ 100 GeV)

DYNAMIC ORIGIN OF THE GRAVITATIONAL CONSTANT AND MODIFIED PLANCKIAN UNITS

Usual gravitational constant γ: indirect, long-range attraction through gravitational medium

"Unified gravity" constant γ_0 in real Planckian units: direct, local protofield attraction:

$$L_P = \left(\frac{\gamma_0\hbar}{c^3}\right)^{\frac{1}{2}} \approx 10^{-17} - 10^{-16}\text{cm} \approx l_{exp} \tag{33a}$$

$$T_P = \left(\frac{\gamma_0\hbar}{c^5}\right)^{\frac{1}{2}} \approx 10^{-27} - 10^{-26}\text{s} \approx t_{exp} \tag{33b}$$

$$M_P = \left(\frac{\hbar c}{\gamma_0}\right)^{\frac{1}{2}} \approx 10^{-22} - 10^{-21} g \ \ (10^2 - 10^3 \ \text{GeV}) \approx m_{exp} \tag{33c}$$

$\gamma_0 = \left(\dfrac{l_{exp}}{l_P}\right)^2 \gamma \approx (10^{33} - 10^{34})\gamma$, $l_P \approx 10^{-33}\text{cm} \ll l_{exp}$ is the ordinary Planckian length (34)

Important consequences and related results [1,4-6]:

causal mass spectrum (no redundant, mathematically "guessed" particle species);
no "hierarchy problem" or postulated "hidden dimensions" (around abstract "manifolds");
dynamic origin and intrinsic unification of "fundamental interactions";
consistent, reality-based explanation of the relative weakness of gravity;
causal theory of "black hole" and other (dense) "quantum condensates";
no "inflation"; no usual "quantum gravity"; etc.

SELF-TUNING UNIVERSE EMERGENCE IN THE UNREDUCED INTERACTION PROCESS

Dynamically emerging universe has dynamically consistent, adaptable structure [1,4]:

dynamic origin of "universal" constants and intrinsic field-particle properties (above)
→ no "miraculous", "anthropic" coincidence in matter structure at any level

Viable, adaptable universe structure emerges for generic protofield interaction parameters:

$$V_{\text{proto}} = M_{\text{univ}}c^2 \quad \Rightarrow \quad M_{\text{univ}} \to \sum_{\text{part}} N_{\text{part}} m_{\text{part}} + V_{\text{int}} \to \sum_{\text{atom}} N_{\text{atom}} m_{\text{atom}} + V_{\text{chem}} \to \dots \qquad (35)$$

Variable universe mass M_{univ} is split into probabilistic, adaptable fractal hierarchy (14)

Non-generic, now causally understood cases of "black holes" and "primordial chaos" [1]

Complex-dynamic universe structure emergence is a self-tuning process as such:

universal dynamic adaptability of unreduced (multivalued) interaction dynamics
→ probabilistic dynamic fractality → symmetry (development) of complexity

Usual, dynamically single-valued cosmology "models" are intrinsically "anthropic":
the ultimate, unified origin of old and new difficulties of any unitary, "postulated" cosmology

POSITIVE TOTAL ENERGY/MASS OF THE UNIVERSE AND REAL TIME ARROW

Universal symmetry of complexity [1-7]: total dynamic complexity, $C = I + S$, is conserved by transformation of decreasing dynamic information I to increasing dynamic entropy S

Dynamic information I is universally measured by complexity-action $\mathcal{A}$:

$$\Delta\mathcal{A} = \Delta I = -\Delta S < 0$$

Total time derivative of action, or (generalised) Lagrangian, is negative
(eventually because of dynamically random realisation change):

$$L = \frac{\Delta\mathcal{A}}{\Delta t} = pv - H < 0\,, \text{ with Hamiltonian } H = E = -\frac{\Delta\mathcal{A}}{\Delta t}\Big|_{x=\text{const}} \qquad (36a)$$

→ Rigorously derived arrow/flow of time oriented to growing complexity-entropy [2,4,7]:

$$L < 0 \quad \Rightarrow \quad E, H(x,p,t) > pv \geq 0\,, \quad \Delta t = \frac{\Delta\mathcal{A}}{L} > 0 \qquad (36b)$$

Time can go ($\Delta t > 0$) only in a universe with positive (conserved) total energy
i.e. any really existing universe ($\Delta t > 0$) has strictly positive total energy balance

Conventional cosmology ("Hamiltonian constraint", Wheeler-deWitt equation, etc.)
strongly prefers zero total energy balance (universe "tunneling from nothing")
accompanied by arbitrarily postulated, mechanistic time flow
→ origin of dark matter, time and entropy problems of usual cosmology:

- the origin of mass/energy is inevitably lost in the single-valued theory projection
- real time cannot exist (flow) in a unitary universe model with zero energy/mass
- any real (multivalued) structure emergence means entropy growth, not decrease
  → solution to all entropy/information problems by the symmetry of complexity
  as the unique Order of the World giving all particular laws and real structures [1-7]

DARK MASS: DYNAMICALLY SINGLE-VALUED (REGULAR) MODEL DEFICIENCY [4]

Usual virial theorem for the time-averaged kinetic $\bar{T}$ and potential $\bar{U}$ system energy:

$$2\bar{T} = -\bar{U} \qquad (37)$$

but in reality this regular kinetic energy $\bar{T} = \bar{T}_{\rm reg}$ is a small part of its total, chaotic content:

$$\bar{T}_{\rm real} = N_{\Re}\bar{T}_{\rm reg} \qquad (38)$$

where $N_{\Re}$ is the effective (average) realisation number ($N_{\Re} = 1$ for usual, unitary models)

The observed potential energy (visible mass), $\bar{U}_{\rm obs}$, correlates with the real kinetic energy

$$2\bar{T}_{\rm real} = -\bar{U}_{\rm obs} \qquad (39)$$

But observations are interpreted within the regular, deficient version of dynamics, eq. (37):

$$2\bar{T}_{\rm reg} = -\bar{U}_{\rm obs} \qquad (40)$$

and therefore one obtains a discrepancy, δ, given by division of eq. (39) by eq. (40):

$$\delta = \frac{\bar{T}_{\rm real}}{\bar{T}_{\rm reg}} = N_{\Re} \qquad (41)$$

which is explained in terms of invisible, "dark" mass, $M_{\rm dark} = M_{\rm real} - M_{\rm reg}$, related to $\bar{U}_{\rm obs}$:

$$\frac{M_{\rm real}}{M_{\rm reg}} = \frac{\bar{T}_{\rm real}}{\bar{T}_{\rm reg}} = \delta = N_{\Re}\ , \quad \frac{M_{\rm dark}}{M_{\rm reg}} = \delta - 1 = N_{\Re} - 1 \qquad (42)$$

The observed discrepancy, or "dark mass", is a measure of complexity/chaoticity C:

$$C = N_{\Re} - 1 = \frac{M_{\rm dark}}{M_{\rm reg}} = \delta - 1 \qquad (43)$$

Since $\bar{T} \propto \overline{Mv^2}$, in reality there is additional motion, rather than mass, in the system:

"dark motion" effect: $\left(\overline{v^2}\right)_{\rm real} = N_{\Re}\left(\overline{v^2}\right)_{\rm reg}$ (44)

Distance-dependent case: $v(r)$ is proportional not to $\sqrt{M_{\rm reg}(r) + M_{\rm dark}(r)}$, but to $\sqrt{N_{\Re}(r)}$:

$$v(r) = \sqrt{\frac{\gamma N_{\Re}(r)\, M_{\rm obs}(r)}{r}} \quad \text{or} \quad N_{\Re}(r) = \frac{rv^2(r)}{\gamma M_{\rm obs}(r)} \qquad (45)$$

where $M_{\rm obs}(r) = M_{\rm real}(r)$ is the ordinary, "visible" mass within radius r

One can derive the features of chaotic dynamics, $N_{\Re}(r)$, from the observed $v(r)$, $M_{\rm obs}(r)$

Chaoticity $N_{\Re}(r)$ will typically have a wide, irregular peak in galactic halo or cluster centre as should be expected

Essential correlations:

- Chaoticity provides unique explanation of the huge diversity of "dark mass" effects
  Expected object chaoticity generally correlates with its dark mass content/location
  Usual, dynamically single-valued "chaos" ($N_{\Re} = 1,\ C = 0$) cannot explain dark mass effects
- A variable property is rather due to a dynamic feature than escaping, fixed entity
  Structural chaos correlates with dynamical chaos and can contribute to the dark mass effects
- Chaoticity is due to effective interaction change, which explains MOND-like features
- Unified solution of problems of mass origin, universe energy/entropy, and dark mass
  Corresponding unified reason for the absence of the same problems solution in usual theory

DARK ENERGY AND BIG BANG CONTRADICTIONS: DEFICIENT UNITARITY [4]

Fundamentally deficient logic (vicious circle) of usual regular, clock-work cosmology:

postulated nothingness of universe content ("tunneling from nothing", "inflation", etc.) →
→ unstable static universe → mechanical expansion (*forced interpretation* of the red shift) → (46)
→ uneven expansion = problems with mass/energy content → return to the starting mistake ↑

The whole dynamically single-valued, zero-complexity model is ***fundamentally unstable***, irrespective of the details → the ***inherent*** problem of "fine-tuned", "anthropic" structure of the ***clock-work, unitary*** universe
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Mechanistic universe construction ***falls inevitably*** as a house of cards
(= "dark matter" + "old" problems)

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Alternative of unreduced, ***complex-dynamic (multivalued) interaction process***:
It's a distributed "big bang" of ***fractal structure creation***, extended ***im***plosion, rather than mechanistic ***ex***plosion and artificial "inflation" of nothingness
creative, structure-forming instability → ***dynamic***, autonomous "fine-tuning"
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Unified solution to ***all*** particular problems of the unitary "model"

The "dark energy" problem does not even appear in the complex-dynamic cosmology:

positive mass/energy of the universe appears *dynamically* from the *unreduced protofield interaction* →
→ *creative instability* of the initially *extended*, but *structureless* universe → no mechanical expansion,
red shift explanation by *physically real* photon interaction with the gravitational protofield→ (47)
→ nonlinear red shift dependence on distance is *natural* for a generic *unreduced* interaction →
→ *no need* for any "dark" quantities, no *model-destructive* instability

Additional features: no angular blur in soliton-like photon interaction with the gravitational medium; red shift data scatter growing with distance; CMBR is a general, quasi-equilibrium e/m protofield excitation (photons) due to all particle quantum beat processes and their changes: its "cosmological" origin is but a special assumption of the incorrect mechanistic approach (46)

UNIFIED EVIDENCE IN FAVOUR OF COMPLEX-DYNAMICAL, CREATIVE UNIVERSE

- Interaction complexity development and conservation provides unique combination of internal change and global stability (no mechanistic universe expansion/shrinking)
  Explicit structure emergence [1-7] vs standard expansion contradictions (Solar system, etc.)
- All problems of universe age and (long-distance) "peculiarities" find new and unified solution in complex-dynamic cosmology (causally explained structure and evolution)
- Natural and unified solution of "old" cosmological problems and all other "mysteries"
  (fractality, flatness, time, entropy, "beginning mysteries", quantum puzzles, etc.)
- Unification with causally complete versions of quantum mechanics, relativity, gravity, field/particle theory, higher complexity levels → the whole world structure emergence
  All the involved properties are first explicitly derived/explained (contrary to other theories): space, time, mass/energy, charge, spin, quantum/classical, unified interactions, etc.
- Universal Symmetry of Complexity as unique, unbroken (exact) Order of the World
  Multivalued dynamical fractal as the unified diversity of resulting structure at all scales
  Explicitly obtained (emergent) and unified diversity of real universe structure and laws

"QUANTUM" AND "RELATIVISTIC" EFFECTS AT ANY COMPLEXITY LEVEL [1]

Arbitrary interaction process at any complexity level:

$$\left\{h_0(\xi)+\sum_{k=1}^{N}\left[h_k(q_k)+V_{0k}(\xi,q_k)\right]+\sum_{k=1,\,l>k}^{N}V_{kl}(q_k,q_l)\right\}\Psi(\xi,Q)=E\Psi(\xi,Q) \qquad (48)$$

$$Q\equiv(q_1,q_2,...,q_N),\quad q_0\equiv\xi,\quad 1\le k,l\le N$$

In terms of internal degrees of freedom:

$$\Psi(q_0,q_1,...,q_N)\equiv\Psi(\xi,Q)=\sum_{n\equiv(n_1,n_2,...,n_N)}\psi_n(q_0)\varphi_{1n_1}(q_1)\varphi_{2n_2}(q_2)...\varphi_{Nn_N}(q_N)\equiv\sum_n\psi_n(\xi)\Phi_n(Q) \qquad (49)$$

$$h_0(\xi)\psi_n(\xi)+\sum_{n'}V_{nn'}(\xi)\psi_{n'}(\xi)=\eta_n\psi_n(\xi) \qquad (50)$$

which is equivalent to the starting system (2) for the first, "quantum" complexity level

The ensuing quantized behaviour at any complexity level is similar but more diverse than quantum behaviour at the first level of complexity (cf. (19)–(21)):

"quantum" uncertainty/discreteness $\Delta x=\frac{\mathcal{A}_0}{p}$, $\Delta t=\frac{\mathcal{A}_0}{E}$, $\mathcal{A}_0\gg h$ is not fixed (51)

Generalised "quantum beat", inertia/mass-energy, and time flow (cf. (16)–(17)):

$$E_0=m_0v_0^2=-\frac{\Delta\mathcal{A}}{\Delta t}=\frac{\mathcal{A}_0}{\tau_0}=\mathcal{A}_0\nu_0\ ,\quad \nu_0=\frac{1}{\tau_0}\ \text{is realisation change frequency} \qquad (52)$$

Generalised "relativistic" dispersion relation reflects chaotic wandering (cf. (22)):

$$E=pV(v),\quad V(v)>v\ \text{is a "phase" velocity function, e.g. } V(v)=\frac{v_0^2}{v} \qquad (53)$$

which gives causal time relativity at any level of (complex) dynamics (cf. (23)):

$$\tau=T\left(1-\frac{v}{V(v)}\right),\quad T\tau=(\tau_0)^2,\quad T=\frac{\tau_0}{\sqrt{1-\frac{v}{V(v)}}}\quad\text{or}\quad N=\nu_0\sqrt{1-\frac{v}{V(v)}} \qquad (54)$$

"Internal" time goes slower within a developing ("moving") system

⇓

causally specified "psychological (subjective) time flow" effects

⇑

Generalised "gravitational" time retardation in external "field" ("general relativity")

Dynamic quantization and generalised (causal) wavefunction (cf. (25)–(26)):

$$\Delta(\mathcal{A}\Psi)=\mathcal{A}\Delta\Psi+\Psi\Delta\mathcal{A}=0\ ,\quad \Delta\mathcal{A}=-\mathcal{A}_0\frac{\Delta\Psi}{\Psi} \qquad (55)$$

$$E=-\frac{\Delta\mathcal{A}}{\Delta t}\Big|_{x=\text{const}}=\frac{1}{\Psi}\mathcal{A}_0\frac{\partial\Psi}{\partial t},\quad p=\frac{\Delta\mathcal{A}}{\Delta x}\Big|_{t=\text{const}}=-\frac{1}{\Psi}\mathcal{A}_0\frac{\partial\Psi}{\partial x} \qquad (56)$$

Causally derived generalised Schrödinger equation (cf. (28)):

$$\mathcal{A}_0\frac{\Delta\Psi}{\Delta t}\Big|_{x=\text{const}}=\hat{H}\left(x,\frac{\Delta}{\Delta x}\Big|_{t=\text{const}},t\right)\Psi(x,t) \qquad (57)$$

NEW MATHEMATICS OF EMERGENCE AND THE SYMMETRY OF COMPLEXITY [1,12]

The single, unified structure in the causally complete, realistic mathematics of complexity uniquely realising its unified symmetry of complexity ("Order of the World"):

dynamically multivalued (causally probabilistic) fractal as the general solution (10)-(14):

$$\rho(\xi,Q)=\sum_{r,r',\ldots}^{N_{\Re}}{}^{\oplus}\rho_{rr'\ldots}(\xi,Q),\quad \rho_{\exp}(\xi,Q)=\sum_{r,r',\ldots}^{N_{\Re}}\alpha_{rr'\ldots}\rho_{rr'\ldots}(\xi,Q),\quad \alpha_{rr'\ldots}=\mathrm{prob}[\rho_{rr'\ldots}]=\frac{N_{rr'\ldots}}{N_{\Re}} \qquad (14)$$

⇓

One can describe any real object, property, phenomenon with absolute rigour and consistency

MAIN FEATURES OF THE NEW MATHEMATICS OF EMERGENCE (properties of the dynamically multivalued fractal of the real world structure)

(I) Nonuniqueness of any real problem solution and its exclusively complex-dynamic (multivalued) existence (cf. usual "existence and uniqueness" theorems)

(II) Fundamental irrelevance of any perturbation theory and "exact solution" concept: dynamic multivaluedness of any real system and unreduced problem solution

→ consistent dynamic origin of nonintegrability, nonseparability, noncomputability, randomness, uncertainty, "broken symmetry", etc.

Real world dynamics is nonintegrable and nonseparable but solvable

Real world mathematics is well defined (certain, unified and complete) but indeterminate and properly diverse (≈ not reduced to numbers or geometry)

(III) Omnipresent dynamic entanglement: interaction-driven structure weaving → rigorous expression of material quality (texture) in mathematics: from over-simplified immaterial "models" to truly exact description of reality

(IV) Omnipresent emergence (change) and real time (event): $a \neq a$ in the new mathematics and reality, while $a = a$ in the whole usual mathematics

No self-identity in the real world and new mathematics of complexity

(V) Dynamic discreteness: quantization, inhomogeneity, nonunitarity → qualitative irrelevance of unitarity, usual continuity and discontinuity, calculus, and all related structures (evolution operators, symmetry operators, any unitary operators, Lyapunov exponents, path integrals, etc.)

Universal, never broken symmetry of complexity unifies properties (I)-(V) of the dynamically multivalued fractal into an irregular, but exactly symmetric world structure

PROBLEM-SOLVING APPLICATIONS OF THE SYMMETRY OF COMPLEXITY [1-12]

MICROWORLD APPLICATIONS: LOWER COMPLEXITY LEVELS

(1) Particle physics

- causal, unified origin and structure of particles, all their properties and interactions
- complex-dynamic origin of mass: no need of extra entities (Higgs, ZPF, etc.)
- renormalised Planckian units: causal mass spectrum without gaps and extra dimensions
- consistent complex-dynamic cosmology: no dark mass and energy, no inflation, etc.

(2) True quantum chaos, causal measurement, and complex-dynamic classicality

- genuine, purely dynamic quantum randomness and correct correspondence principle
- causally complete description of quantum measurement in purely quantum systems
- complex (multivalued) dynamics of intrinsic classicality emergence in a closed system

(3) Realistic, causally complete foundation of nanobiotechnology

- causally complete description of arbitrary nanoscale system interaction
- irreducible role of genuine (multivalued) quantum and classical chaoticity
- exponentially huge power of unreduced, complex nanobiosystem dynamics

(4) Reliable genomics

- causally complete description of unreduced genomic interactions
- irreducible, causally specified role of massive genome interactions
- exponentially huge power of unreduced genome/cell interactions
- evolutionary and genetic implications of unreduced genome interactions

MACROWORLD APPLICATIONS: HIGHER COMPLEXITY LEVELS

consistent cosmology, many-body problem, solid state (strong interaction), unreduced life dynamics, integral medicine, emergent intelligence and consciousness, creative ecology and development science, rigorously specified ethics and aesthetics

UNIVERSAL SYMMETRY OF COMPLEXITY SOLVES REAL-WORLD PROBLEMS

REFERENCES

[1] A.P. Kirilyuk, *Universal Concept of Complexity by the Dynamic Redundance Paradigm: Causal Randomness, Complete Wave Mechanics, and the Ultimate Unification of Knowledge* (Kyiv, Naukova Dumka, 1997), 550 p., in English. For a non-technical overview see also: E-print physics/9806002 at http://arXiv.org.

[2] A.P. Kirilyuk, "Universal Symmetry of Complexity and Its Manifestations at Different Levels of World Dynamics", *Proceedings of Institute of Mathematics of NAS of Ukraine* **50** (2004) 821-828. E-print physics/0404006 at http://arXiv.org.

[3] A.P. Kirilyuk, "Dynamically Multivalued Self-Organisation and Probabilistic Structure Formation Processes", *Solid State Phenomena* **97-98** (2004) 21-26. E-print physics/0405063.

[4] A.P. Kirilyuk, "Complex-Dynamic Cosmology and Emergent World Structure", Report presented at the International Workshop on Frontiers of Particle Astrophysics (Kiev, 21-24 June 2004). E-print physics/0408027 at http://arXiv.org.

[5] A.P. Kirilyuk, "Quantum Field Mechanics: Complex-Dynamical Completion of Fundamental Physics and Its Experimental Implications", E-print physics/0401164 at http://arXiv.org.

[6] A.P. Kirilyuk, "Double Solution with Chaos: Dynamic Redundance and Causal Wave-Particle Duality", E-print quant-ph/9902015 at http://arXiv.org.

A.P. Kirilyuk, "Double Solution with Chaos: Completion of de Broglie's Nonlinear Wave Mechanics and Its Intrinsic Unification with the Causally Extended Relativity", E-print quant-ph/9902016 at http://arXiv.org.

[7] A.P. Kirilyuk, "Dynamically Multivalued, Not Unitary or Stochastic, Operation of Real Quantum, Classical and Hybrid Micro-Machines", E-print physics/0211071 at http://arXiv.org.

[8] A.P. Kirilyuk, "Complex Dynamics of Real Nanosystems: Fundamental Paradigm for Nanoscience and Nanotechnology", *Nanosystems, Nanomaterials, Nanotechnologies* **2** (2004) 1085-1090. E-print physics/0412097 at http://arXiv.org.

[9] A.P. Kirilyuk, "Quantum chaos and fundamental multivaluedness of dynamical functions", *Annales de la Fondation Louis de Broglie* **21** (1996) 455-480. E-print quant-ph/9511034 – 36.

[10] A.P. Kirilyuk, "Theory of charged particle scattering in crystals by the generalized optical potential method", *Nucl. Instr. Meth. B* **69** (1992) 200–231.

[11] A.P. Kirilyuk, "Causal Wave Mechanics and the Advent of Complexity. IV. Dynamical origin of quantum indeterminacy and wave reduction", E-print quant-ph/9511037 at http://arXiv.org.

[12] A.P. Kirilyuk, "Complex-Dynamical Extension of the Fractal Paradigm and Its Applications in Life Sciences", Report at the IVth International Symposium "Fractals in Biology and Medicine" (Ascona, 10-14 March 2004). E-print physics/0502133 at http://arXiv.org.

A.P. Kirilyuk, "The Universal Dynamic Complexity as Extended Dynamic Fractality: Causally Complete Understanding of Living Systems Emergence and Operation", In: G.A. Losa, *et al.* (Eds.), *Fractals in Biology and Medicine, Vol. III*. (Basel, Birkhäuser, 2002), p. 271-284. E-print physics/0305119 at http://arXiv.org.