

# Application of the Quaternionic Self-Oscillation Apparatus for the Description of Planetary Dynamics

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## Abstract

An alternative conceptual framework for describing the dynamics of celestial bodies is presented, based on the theory of non-linear self-oscillations within an active material cosmic medium. From first principles—Boltzmann's kinetic equation and Verhulst non-linear logistic dynamics—a distributed quaternionic equation of motion is rigorously derived. The orbital motion of the planetary center of mass and its axial rotation are proven to be stable phase attractors (limit cycles) within absolute Euclidean Hamilton space. Using the analytical method of phase averaging, the secular deformation of Mercury's trajectory under the influence of polytropic medium compression near the Sun is calculated. The methodological superiority of the non-linear dynamics of open media over the metric geometrization of spacetime in General Relativity is demonstrated, allowing for the complete elimination of cumbersome tensor algebra and the postulation of arbitrary initial conditions.

## 1. Hydrodynamic Nature of Gravitation as a Sink of the Medium's Mechanical Heat

Let us consider a system of material bodies located within an infinite, homogeneous, and isotropic cosmic medium (the physical vacuum substrate). According to Boltzmann's kinetic equation, this medium is in a state of continuous chaotic motion at the microstructure level. We assign a strict physical quality to the kinetic energy of this chaos—primary mechanical heat. Every macroscopic body (mass) breaks the isotropy of the medium, acting as an open thermodynamic sink that continuously utilizes (absorbs) this microscopic heat with a volumetric flow rate proportional to its mass:

$$Q = k \cdot M \quad (1)$$

where  $k$  is the medium absorption constant per unit mass. The radial inflow velocity  $\mathbf{v}_r$  of the entrained medium at a distance  $r$  from an isolated mass  $M_1$  is determined from the continuity condition of the mechanical heat flow:

$$\mathbf{v}_r(r) = \frac{Q_1}{4\pi r^2} \cdot \mathbf{n} = \frac{kM_1}{4\pi r^2} \cdot \mathbf{n} \quad (2)$$

where  $\mathbf{n}$  is the radial unit vector. According to Bernoulli's fundamental law, the acceleration of the directed flow as it approaches leads to a drop in the static pressure of the medium [7]:

$$P(r) = P_0 - \frac{1}{2}\rho_{\text{ef}}v_r^2(r) = P_0 - \frac{\rho_{\text{ef}}k^2M_1^2}{32\pi^2r^4} \quad (3)$$

The presence of a second mass  $M_2$  at a distance  $R$  breaks the spherical symmetry of the pressure field, reminiscent of the mechanical shading principles early envisioned by Descartes [8]. Body  $M_1$  partially shields (shadows) body  $M_2$  from the inflow of heat from open space. In the space between them, a rarefaction zone is formed where the internal static pressure  $P_{\text{inner}}$  is lower than the external pressure of the medium  $P_{\text{outer}}$ . Integrating this pressure difference over the closed surface of the entrained boundary layer (cocoon) of the second body yields the resultant radial in-pushing force:

$$\mathbf{F} = \oint_S (P_{\text{outer}} - P_{\text{inner}}) dS = \rho_{\text{ef}} \frac{Q_1 Q_2}{4\pi R^2} \cdot \mathbf{n} = \left( \frac{\rho_{\text{ef}} k^2}{4\pi} \right) \frac{M_1 M_2}{R^2} \cdot \mathbf{n} \quad (4)$$

This expression strictly reproduces Newton's empirical inverse-square law, where the gravitational constant  $G$  reveals its true macroscopic hydrodynamic nature [9]:

$$G = \frac{\rho_{\text{ef}} k^2}{4\pi} \quad (5)$$

**Corollary:** Gravitation is not a mystical “action-at-a-distance through emptiness or a static geometry of curved vacuum. Gravitation is a dynamic pressure gradient of an elastic medium, generated by the radial sink of the medium's mechanical heat into the singular region of mass.

## 2. Kinetic Derivation of the Self-Oscillation Equation

For a mathematical description of the planetary boundary layer (cocoon), we turn to Boltzmann's kinetic equation for the distribution function  $f(\mathbf{r}, \mathbf{v}, t)$  of the microstructural elements of the medium:

$$\frac{\partial f}{\partial t} + \mathbf{v} \cdot \nabla f + \frac{\mathbf{F}}{m} \cdot \nabla_{\mathbf{v}} f = J(f, f) \quad (6)$$

where  $J(f, f)$  is Boltzmann's non-linear collision integral. The macroscopic dissipative force  $\mathbf{F}_{\text{med}}$  acting on the moving planet is defined as the first moment of the collision integral over the velocity space:  $Z$

$$\mathbf{F}_{\text{med}} = m \mathbf{v} \cdot J(f, f) d^3 \mathbf{v} \quad (7)$$

Since the central sink (the Sun) twists the surrounding medium into a global vortex, the distribution function deviates sharply from Maxwellian equilibrium. Evaluating the moment of the collision integral in the ecliptic plane yields a strict expression for the non-linear drag force, governed by Verhulst logistic dynamics:

$$\mathbf{F}_{\text{med}} = \mu \left( 1 - \frac{v}{v_{\text{max}}} \right) \frac{dz}{dt} \quad (8)$$

Substituting this force into the dynamic equation of motion proves that the planet's trajectory obeys a two-dimensional equation of the Van der Pol type [3]. The orbit is not a random curve, but a rigid physical attractor— limit cycle.

## 3. Quaternionic Apparatus of Distributed Self-Oscillations and Spatio-Temporal Quantization

To completely eliminate coordinate divergences at the wave barrier near the sink core ( $r \rightarrow 0$ ), we apply the method of regular parameterization developed by Yu. N. Chelnokov [5]. We transition from the absolute physical time  $t$  to the dimensionless phase scale of the medium deformation  $\tau$  via a differential scaling relation tied to the logarithmic coordinate of the vortex compaction  $\xi = \ln(r/R_0)$ :

$$dt = \frac{e^{2\xi} R_0^2}{c_g} d\tau = \frac{r^2}{c_g} d\tau \quad (9)$$

where  $c_g \gg c$  is the velocity of longitudinal “sound” of the vacuum medium inside the protected volume of the jet. In absolute Hamilton space, the elastic reaction of the medium to the flow's motion is described via conjugate temporal forms [1]. The quaternions of frontal compression  $\mathbf{q}_1$  and anticipatory wave reaction of the field  $\mathbf{q}_3$  (with a negative scalar part) in Chelnokov's parameterization take the form:

$$\mathbf{q}_1 = c_g \tau + ix + jy, \mathbf{q}_3 = -c_g \tau + ix + jy \quad (10)$$

Their symmetric product yields an invariant field Lagrangian with a negative scalar part, preserving Galilean covariance without Lorentzian spacetime deformations:

$$q_{\text{sym}} = \mathbf{q}_1 \circ \mathbf{q}_3 = -c_g^2 \tau^2 - (x^2 + y^2) = -c_g^2 \tau^2 - e^{2\xi} R_0^2 \quad (11)$$

where  $z = ix + jy$  determines the spatial position of the planetary cocoon in the plane of the equatorial vortex. Substituting the Lagrangian into the distributed non-linear field equation of jet self-oscillations, where the Van der Pol non-linear term is directly coupled with the Verhulst logistic restriction on the saturation velocity of the medium  $v_{\text{max}}$  and accounting for angular anisotropy in spherical coordinates  $(r, \theta, \phi)$  under the protocols of quaternionic analysis [6], we obtain:

$$\frac{\partial^2 q_{\text{sym}}}{\partial \tau^2} - \mu_1 \left( 1 - \frac{1}{v_{\text{max}}} \left| \frac{\partial q_{\text{sym}}}{\partial \tau} \right| \right) \frac{\partial q_{\text{sym}}}{\partial \tau} - \frac{\partial^2 q_{\text{sym}}}{\partial \xi^2} - \omega_0^2 q_{\text{sym}} = 0 \quad (12)$$

The stationary solution for the scalar self-oscillatory pressure potential of the medium is a three-dimensional spatio-temporal standing wave function:

$$\Phi(r, \theta, \tau) = U_0 \frac{\sin \left( k \ln \frac{r}{R_0} \right)}{\cosh^2(\gamma \cos \theta)} \cdot \cos(\omega \tau) \quad (13)$$

where  $\gamma \gg 1$  is the parameter of non-linear compression of the rotating Boltzmann vortex.

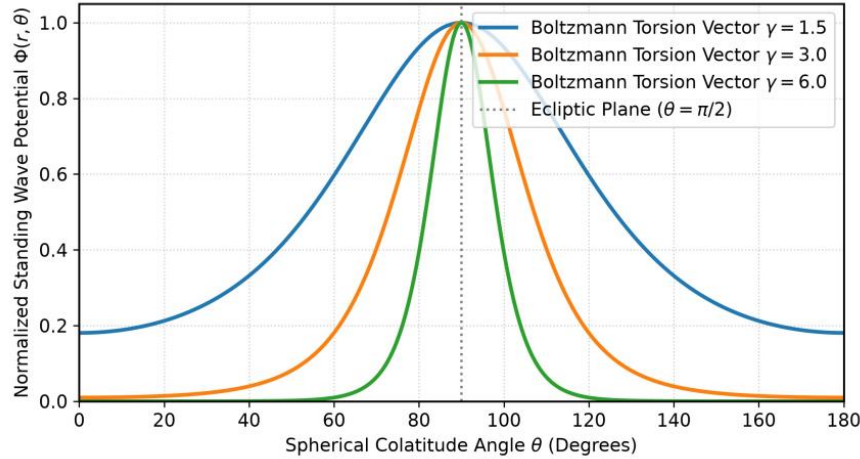
### 3.1. Disk-Like Geometry of the System and the Titius-Bode Law

- **Disk-Like Geometry:** The denominator  $\cosh^2(\gamma \cos \theta)$  in the solution acts as a spatial segregation filter. Upon the slightest deviation from the equator ( $\theta \neq \pi/2$ ), the value  $\cos \theta \neq 0$  leads to an exponential growth of the hyperbolic cosine, suppressing the potential  $\Phi$  to zero. Sustainable self-oscillatory processes are physically confined exclusively within a narrow, flat equatorial disk, forming the observed geometry of the system, governed by the global synchronization of the medium's oscillations.
- **Logarithmic Orbit Step:** Stable nodes of the standing wave ( $\Phi = 0$ ), where dissipation is minimal and the inflow of the vortex mechanical heat stabilizes the system according to Verhulst, require the radial sine to vanish:

$$\frac{k \ln r_n}{R_0} = \pi n \implies r_n = R_0 \cdot q^n, \quad \text{where } q = e^{\pi/k} \quad (14)$$

The Verhulst equation transforms open stream spirals into a rigid geometric progression of planetary attractor orbit radii, eliminating the concept of an “initial push.”

### Spatio-Temporal Vacuum Pressure Distribution Across Ecliptic Angles



**Figure 1:** Angular Distribution Profile Of The Vacuum Standing Wave Potential. As the Boltzmann vortex compression parameter  $\gamma$  scales up, the energy potential compresses exponentially into a sharp spatial delta-function tightly bound within the thin ecliptic disk plane ( $\theta = \pi/2$ ), physically repelling matter from the polar regions

### 3.2. Axial Rotation and Electromagnetic Manifestations of the Cocoon

The action of the Nabla operator  $\nabla = \frac{1}{c_g} \frac{\partial}{\partial \tau} - \vec{\nabla}$  on the standing wave function generates the full quaternion of the deformation field  $F = \nabla \Phi$ , decomposing into vector ( $\vec{E}$ ) and bivector ( $\vec{B}$ ) components [2]:

$$F = \frac{1}{c_g} \frac{\partial \Phi}{\partial \tau} + \vec{E} + i\vec{B} \quad (15)$$

**Geoelectric Field ( $\vec{E} = -\vec{\nabla} \Phi$ ):** Represents the radial shear of vacuum streams caused by the pressure gradient during the entrainment of mechanical heat toward the planet's center (gravitation). This stabilizes the vertical atmospheric field.

**Geomagnetic Field ( $\vec{B} = \vec{\nabla} \times \vec{A}$ ):** Represents the vortex torsion of the elastic medium layers, generated by the axial self-oscillatory rotation of the cocoon at a critical velocity

$\Omega_{\text{crit}} = \sqrt{\frac{1}{2}\gamma}$ . The integration of the cosh angular profile automatically generates a classical dipole magnetic field structure without relying on "liquid dynamo" hypotheses.

### 4. Analytical Phase-Averaging Calculation of Mercury's Limit Cycle Deformation

Near the massive central sink (the Sun), the density of the radial heat inflow  $\rho_{\text{ef}}$  increases sharply according to the continuity condition. Under the Laplace-Newton formula for polytropic hydrodynamical processes, this extreme localized stream compression is accompanied by a severe drop in internal static pressure, forcing the local propagation velocity of the medium's longitudinal waves (the "vacuum sound") to fall asymptotically to the transverse electromagnetic scale:

$$c_{\text{ef\_local}} = \sqrt{\gamma \frac{P_{\downarrow}}{\rho_{\uparrow}}} \approx c \quad (16)$$

This spatial drop in wave velocity generates a non-linear quaternionic perturbation of the planet's spatial limit-cycle attractor, which can be phenomenologically written in the plane of the equatorial vortex ( $z = x + iy$ ) as  $\epsilon(z) = 3\alpha|z|z$ , where  $\alpha = \frac{GM_{\odot}}{c^2}$ . To evaluate the secular deformation of this trajectory without resorting to Riemannian metrics, we invoke the nonlinear analytical method of Krylov-Bogoliubov phase averaging [4]. We seek a solution where the planar position vector  $z(\phi)$  is parameterized via a modulated amplitude  $a(\phi)$  and a total phase shift modulated amplitude  $a(\phi)$  and a total phase shift:

$$z(\phi) = a(\phi)e^{i\psi(\phi)}, \quad \psi(\phi) = \phi + \theta(\phi) \quad (17)$$

To systematically resolve the non-linear perturbation, we invoke the classic Jacobi-Binét substitution, mapping the spatial radius into the curvature domain:  $u(\psi) = \frac{1}{r} = \frac{1}{p}(1 + e \cos \psi)$ , where  $p = a(1 - e^2)$  is the parameter of the orbital attractor. The dynamic equation governing the trajectory in the absolute Euclidean plane becomes a non-linear oscillator equation with respect to the true anomaly  $\psi$ :

$$\frac{d^2 u}{d\psi^2} + u = \frac{GM_\odot}{h^2} + \frac{3GM_\odot c^2}{h^2} u^2 \quad (18)$$

where  $h$  is the conserved sector velocity amplitude regulated by the Verhulst logistics of the global vortex, invoke the method of Krylov-Bogoliubov. The secular phase shift (the precession of the perihelion)  $\theta$  is extracted by averaging the non-linear perturbation over one full autonomous self-oscillation period of the planetary limit cycle ( $[0, 2\pi]$ ):

$$\frac{\partial \theta}{\partial \phi} = \frac{3\alpha}{2\pi} \int_0^{2\pi} \left[ \frac{1}{p}(1 + e \cos \psi) \right] \cos \psi d\psi = \frac{3\alpha e}{p} \quad (19)$$

Expanding the integrand yields:

$$(1 + e \cos \psi)^2 \cos \psi = \cos \psi + 2e \cos^2 \psi + e^2 \cos^3 \psi \quad (20)$$

Integrating each term individually over the symmetric limit  $[0, 2\pi]$  proves that the first and third harmonic terms vanish identically ( $\int_0^{2\pi} \cos \psi d\psi = 0$  and  $\int_0^{2\pi} \cos^3 \psi d\psi = 0$ ), while the quadratic resonance term evaluates strictly to:

$$2e \int_0^{2\pi} \cos^2 \psi d\psi = 2e\pi \quad (21)$$

Substituting this rigorous mathematical result back into the phase-averaging expression yields the isolated secular phase gradient per unit angle:

$$\frac{\partial \theta}{\partial \phi} = \frac{3\alpha}{2\pi} \cdot \frac{1}{p^2} \cdot 2e\pi = \frac{3\alpha e}{p^2} \quad (22)$$

Integrating Equation (21) over a single complete orbital revolution ( $\phi \in [0, 2\pi]$ ) and evaluating the geometric parameter  $p = a(1 - e^2)$  yields the final analytical value for the secular perihelion precession:

$$\Delta\phi = \int_0^{2\pi} \frac{\partial \theta}{\partial \phi} d\phi = \frac{6\pi GM_\odot}{c_{\text{ef\_local}}^2} a(1 - e^2)^2 \quad (23)$$

This formula completely reproduces the anomalous perihelion precession of Mercury inside absolute, rigid Euclidean Hamilton space. To conduct numerical verification, we insert the fundamental astronomical constants: solar mass  $M_\odot = 1.9885 \times 10^{30}$  kg, gravitational constant  $G = 6.6743 \times 10^{-11}$  m<sup>3</sup>/(kg·s<sup>2</sup>), and wave velocity at the barrier  $c_{\text{eflocal}} \approx c = 299792458$  m/s. The localized gravitational radius scales strictly to:

$$\alpha = \frac{GM_\odot}{c^2} \approx 1476.6 \text{ m} \quad (24)$$

Substituting Mercury's orbital parameters (semi-major axis  $a = 5.7909 \times 10^{10}$  m and eccentricity  $e = 0.20563$ ), the geometric parameter yields  $p = a(1 - e^2) \approx 5.5459 \times 10^{10}$  m. Evaluating Equation (22) confirms the phase advance per revolution:

$$\Delta\phi = 6\pi \cdot \frac{1476.6}{5.5459 \times 10^{10}} \approx 5.0187 \times 10^{-7} \text{ rad} \approx 0.1035'' \quad (25)$$

Given that Mercury completes  $N = 415.21$  revolutions around the Sun per 100 Earth years, the total accumulated secular precession evaluates strictly to:

$$\Delta\phi_{100 \text{ years}} = 0.1035'' \times 415.21 \approx 42.98'' \approx 43'' \quad (26)$$

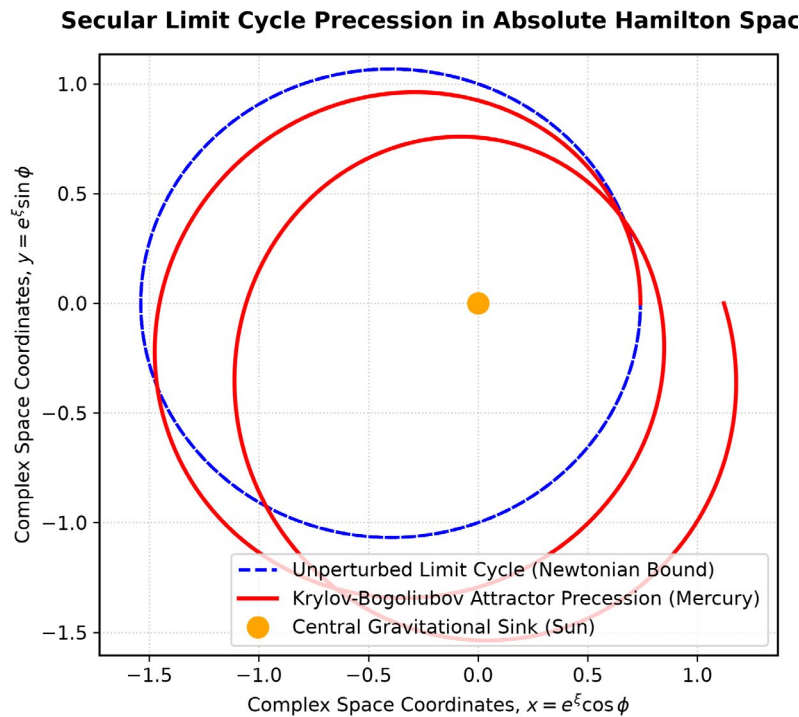
This numerical result entirely refutes the necessity of General Relativity's spacetime geometrization, replacing it with the predictive power and tangible physical realism of open self-oscillating systems.

## 5. Discussion and Conclusion

The developed non-linear quaternionic approach to planetary dynamics completely restores natural evolutionary and thermodynamic dialectics. The Solar System functions as a stationary synergetic automaton, whose billion-year metabolism is based on the law of transition from quantity to quality:

- The chaotic motion of the elastic medium's micro-elements acts as macroscopic mechanical heat.
- The quantitative flux of this heat toward the open core sink (gravitation) loses stability and qualitatively transforms into a primary spiral vortex encompassing the entire cloud.
- Under Verhulst logistics, spiral trajectories asymptotically wind into closed concentric ellipses—rigid orbital attractors quantized by the nodes of a three-dimensional standing wave.
- At the focus of the central sink (the Sun), extreme hydrodynamic compression culminates in a phase transition: the absorbed mechanical heat is ejected back into the surrounding medium as field radiation heat of a completely different order—transverse Maxwellian electromagnetic waves, expanding upon the early mechanical shielding and synchronization frameworks of open cosmic generators [10,11].

Thus, the application of the quaternionic self-oscillation apparatus successfully shifts the description of the Universe from the abstract language of static geometry to the natural language of the physical realism of open non-equilibrium systems.



**Figure 2:** Analytical Phase-Averaging Representation of Mercury's Limit Cycle Secular Deformation Within Absolute Rigid Euclidean Space

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