LATTICE TENSION THEORY

Quantum Energy Cells and the Origin of Matter Gravity and Spatial Rupture

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ABSTRACT

Lattice Tension Theory proposes that observable space consists of cubic quantum cells whose interiors can receive quantum energy packets from an arena with four spatial dimensions. Matter consists of persistent configurations of these packets. Occupation loads the elastic edges of the cells, and the resulting vibrations couple across the network. Gravitation is interpreted as the collective response of this loaded structure and its tendency to restore phase coherence. The network also has a finite carrying capacity and a finite resistance to fracture. Small breaks can reconnect, whereas sustained overload can remove the cellular enclosure itself and create a region without an operative three-dimensional lattice. Such a region is proposed as the microscopic structure of a black hole. Its gravitational influence is attributed to the surviving boundary, while exchange with the higher-dimensional sector provides a candidate source of boundary radiation.

We formulate these ideas at two complementary levels. A discrete description separates packet occupation, edge extension, connectivity, and cell existence. An effective scalar action describes the intact gravitational response through a load-dependent elastic coefficient. Its variational field equation retains the nonlinear structure of the original LTT proposal, fixes the normalization and attractive-force convention, and supplies a well-defined discrete counterpart. Conditional analytical results include the Newtonian limit, an exact spherical exterior, a surface-source boundary condition, and an energy threshold for edge failure. The distinction between an empty cell and a missing cell is maintained throughout. Universal time is introduced as an ordering postulate, with changes in clock readings attributed to changes in material transition rates. This article establishes the physical construction and its mathematical starting point; quantitative galaxy comparisons, clock dynamics, and compact-object solutions are reserved for subsequent studies.

1 THE PHYSICAL STARTING POINT

The proposal begins with a distinction between the existence of space and the presence of matter in it. A region can contain no localized matter while still providing the relations through which light, signals, and material configurations propagate. LTT assigns those relations a physical structure: a connected assembly of quantum cells. The unoccupied network is the vacuum. Matter appears when energy entering the network organizes into a configuration that can persist, interact, and move. The same network that permits this organization is loaded by it, so the origin of matter and the origin of gravitation become connected questions.

The cells are taken to be cubic in their unstrained reference state. Their interiors contain no ordinary material substrate; their edges and mutual connections establish the observable spatial structure. Quantum energy packets, abbreviated QEPs, can occupy the interiors. A packet is a proposed energy-bearing excitation, and its energy need not be a universal fixed number independent of its state. Different packet arrangements are hypothesized to underlie different particle configurations. A stable object is therefore an organized process sustained on the network, rather than a permanently filled piece of space.

The source of accessible excitation is an arena with four spatial dimensions. Transfer into the three-dimensional network depends on local compatibility between the two sectors and can occur at different times with different amounts of energy. The observable sector is consequently open when considered alone. What appears as the appearance or disappearance of accessible matter may be exchange with degrees of freedom outside that sector. The combined description must retain the energy and correlations involved in the transfer. This principle is particularly important when the network changes its own connectivity.

Occupation is assumed to load cell edges. An elastic edge stores energy and transmits disturbances to adjacent edges; vibrations from different occupied regions can interact and develop phase correlations. LTT identifies the long-range collective response with gravitation. The original intuition that gravity restores coherence is given a concrete role: the network and its excitations evolve under interactions that can lower their energy by reorganizing their relative phases and strains. The direction and strength of the observable force still have to follow from those interactions. Phase coherence by itself does not specify an inverse-square law.

A finite elastic structure can also fail. Small local breaks may be rapidly repaired as displaced endpoints oscillate toward compatible neighbours. A sufficiently large and persistently loaded cluster can instead lose the closed cellular organization needed for ordinary three-dimensional propagation. LTT calls the resulting region a spatial rupture or absolute void. It proposes that a black hole is such a rupture surrounded by a strongly loaded, active boundary. The interior contains neither ordinary matter configurations nor the cells that would support them. The exterior field must then be sourced by the surviving boundary and its interaction with the rest of the system.

This distinction gives the proposal its main physical content. An empty cell and a spatial rupture can both lack localized matter, but only the former retains the structure through which ordinary signals travel. A theory that merely lowers a propagation coefficient everywhere does not capture that distinction. The mathematical description must permit a cell to cease to exist as an operative element, account for the excitation released in that change, and determine the behaviour of the new boundary. That requirement guides the formulation below.

The purpose of this first article is to state the construction and give it a consistent starting dynamics. Higher-dimensional localization and persistent nonlinear excitations have established mathematical precedents [1,2]. Elastic fracture supplies another relevant body of methods [3,4]. Here these ingredients are assigned a particular physical interpretation and connected through the cell model. They do not establish that space is a material lattice. The proposal is developed as a candidate theory whose parameters, solutions, and observational consequences can be investigated without replacing its central physical assumptions by a different gravitational law.

2 SPATIAL CELLS AND TRANSFER FROM FOUR DIMENSIONS

The dimensional picture can be introduced by considering an observer with access to only part of a larger structure. A sphere crossing a plane produces a section that begins as a point, becomes a circle, and disappears. The sphere need not begin or end when the section does. The lower-dimensional observer sees a history of accessible intersections. In LTT, ordinary matter is proposed to have a related higher-dimensional origin, with physical transfer and stabilization added to the geometry of intersection.

This example is a section through an object, rather than its orthogonal projection. The distinction is useful because a projected shadow can remain present when the object no longer intersects the observing plane. A physical packet also requires an interaction that transfers energy or establishes an accessible state. The crossing analogy therefore illustrates restricted observation; resonance and coupling supply the proposed physical mechanism. The appearance of a geometrical section alone is not identified with quantum tunnelling or quantum interference.

The original dimensional intuition treats a line as an ordered extension of locations, a plane as a family of such extensions, and ordinary space as a further independent extension. We retain this as a construction of accessible relations. A single point is not automatically a physical state without energy or an evolution law, and a collection of points does not select its own topology. The proposed pre-spatial state is instead defined to have no operative separation and no material process by which duration could be measured. Connected relations and changes must be introduced before the model can describe distances and clocks.

Directions are independent labels of extension, not intersecting physical rods. This gives a precise reading of the original statement that dimensional axes do not intersect: no microscopic collision of coordinate axes is required to make a dimension. In a mathematical coordinate chart the axes can of course share an origin. Likewise, calling the reference network unbounded and symmetric specifies an ideal background for calculation; it does not prove that every possible spatial manifold is infinite, linear, or inversion symmetric. The physical postulate concerns the reference state of this model.

Locally, the higher-dimensional arena can be labelled by coordinates (x, y, z, w). The coordinate w is spatial and is not the time parameter used to order change. The description of this arena as simultaneously inward and outward relative to every observable location expresses local access to a direction unavailable within ordinary space. It need not be reached by travelling to the edge of the observable universe. The three-dimensional sector can couple to it wherever the required local conditions occur. The global geometry and the mechanism selecting the observable sector are left to a more microscopic construction.

The cubic cells are fundamental elements of the proposed spatial organization. We take their unstrained edge length to be the Planck length, $\ell = \ell_{Pl}$, as an explicit scale postulate. No calculation in this article derives that choice. The scale fixes a reference spacing, while the strained lengths and the organization of connected cells can change. A geometric cube has twelve edges and six faces. A cell-centred cubic representation has six nearest neighbours. These are different counts, and the notation below distinguishes structural edges from adjacency between cell centres.

The interior of an unoccupied cell is termed empty because it has no QEP configuration. It remains enclosed and connected to neighbouring cells. A cell carrying QEPs has the same kind of enclosure but an additional accessible excitation and a changed load. A missing cell is different again: the enclosure is no longer part of the operative three-dimensional network. This three-way distinction is more informative than a binary division between matter and empty space, especially near a developing crack.

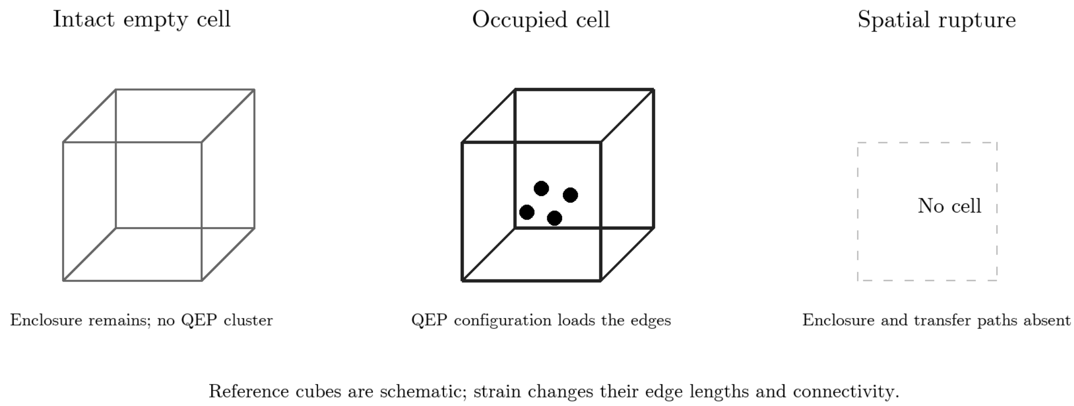

Figure 1. The three physical states distinguished in LTT. An empty cell retains its enclosure, an occupied cell carries a QEP configuration and loads its edges, and a spatial rupture has no operative cell in its interior. Lines denote structural edges; dots denote schematic excitation, not identified particle species.

Let η_i indicate whether cell i exists as an operative enclosure, and let b_{ij} indicate whether an accessible transfer connection between cells i and j is present. The occupation n_i is distinct from either variable. One possible bookkeeping convention is:

$$\eta_i \in \{0,1\}, \qquad b_{ij} \in \{0,1\}, \qquad b_{ij} \le \eta_i \eta_j, \qquad 0 \le n_i \le \eta_i n_{max}.$$

The parameter n_{max} represents a carrying-capacity postulate for the chosen effective packet description. It is not an independently measured universal particle count. A limit on local occupation is also different from a limit on the total energy of an extended body. If packets have different energies or internal quantum numbers, their admissible combinations require additional constraints. The original capacity idea can therefore be retained without inferring upper bounds on every physical observable from a single number.

At the level of a simple exchange process, let ψ_i represent an accessible mode and Ψ_a a mode in the higher-dimensional sector. A Hermitian interaction can transfer excitation between them:

$$H_{ex} = \sum\nolimits_{i,a} (\lambda_{ia}\psi_i^*\Psi_a + \lambda_{ia}^*\Psi_a^*\psi_i).$$

The coefficients λ may depend on cell state, strain, and the compatibility of the two modes. Their time dependence must arise from evolving variables in a closed model; prescribing it externally introduces work by the external agent. The usual Hamiltonian amplitude equations conserve the combined mode norm when the complete Hamiltonian has a common phase symmetry. For a fixed, autonomous Hamiltonian they also conserve total energy. Norm conservation and energy conservation are different statements, and neither makes the accessible sector closed by itself.

For a cell that continues to exist, an occupation balance can be written in terms of antisymmetric intercell currents J_{ij} and net transfer I_i from the higher-dimensional sector:

$$\frac{dn_i}{d\tau} = I_i - \sum\nolimits_j J_{ij}\,, \qquad J_{ij} = -J_{ji}.$$

Summing this equation over the operative cells cancels internal currents. The accessible occupation changes through exchange with the larger sector and through boundary processes. If a cell is removed, the packet state cannot simply be erased from the calculation: its energy and correlations must be reassigned to surviving cells, the boundary, or the higher-dimensional sector. The variable η records the structural change; a separate transfer rule records what happened to the excitation.

Different transfer events can have different durations and strengths. An isolated event may seed a configuration that becomes weakly coupled to the source after it forms. Alternatively, a persistent accessible state may be part of a stationary joint configuration with balanced exchange. Both possibilities implement a higher-dimensional origin without requiring ordinary matter to gain or lose mass continuously at a large rate. The observed persistence of material systems would constrain the residual exchange and the lifetime of the resulting configurations.

The theory associates particle identity with a stable organization of packet occupations, phases, and connections. Configurations with equal total excitation may still differ in symmetry or phase structure. Nonlinear networks can support persistent localized oscillations under appropriate conditions [2], making this a meaningful mathematical programme. To identify a configuration with a quark, electron, or photon, however, the model must reproduce its measured quantum numbers, statistics, interactions, and dispersion. The figures in this article represent organization in general; they are not microscopic reconstructions of known particles.

Motion is the transfer of that organization through successive cells. The same cells do not have to remain occupied for the configuration to retain its identity. What must persist is the pattern's dynamical structure, including any conserved quantities that distinguish it. This interpretation connects inertial behaviour to the energy cost of changing the propagation of an organized state. A microscopic completion must then relate that cost to the same state's gravitational loading, so that inertial and gravitational response are not independently assigned for each species.

3 ELASTIC LOADING RESONANCE AND REPAIR

An occupied cell is proposed to disturb its enclosing edges and the adjoining network. The rubber analogy concerns elastic extension, finite restoring force, and eventual failure. It does not imply that cell edges are made of an ordinary substance or share its measured elastic constants. The mechanical variables below describe a candidate microscopic response. Their purpose is to make the source of stored energy and the conditions for breaking explicit.

Consider an intact structural edge e with reference length ℓ, actual length L_e, and stiffness k_e in force per unit length. Write its geometric strain as $\varepsilon_e = (L_e - \ell)/\ell$. A loading variable ν_e describes nearby QEP occupation, normalized to the chosen cell capacity. For an edge shared by several cells, ν_e can be their weighted mean; the weights are nonnegative and sum to one. One simple occupation-dependent natural length is $\ell(1 - \zeta\nu_e)$, where ζ is dimensionless and the permitted occupation range keeps that natural length positive. The occupied region then tends to shorten an edge's relaxed length, putting a constrained surrounding network under tension.

For this illustrative tensile-loading law, the elastic extension relative to the loaded natural length is $\ell(\varepsilon_e + \zeta\nu_e)$. The stored energy and tensile force are:

$$E_e = \frac{k_e \ell^2}{2}(\varepsilon_e + \zeta\nu_e)^2, \qquad F_e = k_e \ell(\varepsilon_e + \zeta\nu_e).$$

These equations show how occupation can create stress even before the surrounding geometry moves. A constrained edge with $\varepsilon_e = 0$ acquires positive tensile force when ν_e is positive. A freely relaxing collection can rearrange and reduce that force. The sign of the occupation-dependent natural-length change is part of the proposed microscopic interaction, not an established property of vacuum. Other constitutive choices can be investigated, but they must specify how packet energy pays for the induced deformation.

The edge energy is a mechanical description at the cell level. Later, the scalar field energy represents a coarse-grained response of the same structure. The two descriptions must be related by averaging; they should not be added as independent copies of the same stored energy. Similarly, the packet's energy, the change in elastic energy, and the work done on neighbouring cells must be included in one consistent bookkeeping scheme when occupation changes. An imposed load can inject energy; an internally generated load must draw it from other degrees of freedom.

Neighbouring occupied cells also induce oscillations. Let ϑ_i describe a phase of the local excitation, with a positive coupling J_{ij} on an intact transfer connection. A simple phase-locking contribution is $J_{ij}[1 - \cos(\vartheta_i - \vartheta_j)]$. It is minimized when the phases agree modulo a full cycle. Its derivative supplies a restoring phase interaction. This gives an explicit mathematical meaning to the tendency toward coherence invoked in the original idea. An isolated conservative network can exchange phase and mechanical energy without settling permanently; effective relaxation requires dephasing into other modes or an energy-carrying environment.

The quiet vacuum is interpreted as the low-occupation, synchronized reference state of the network. Occupied regions disturb it, and the disturbance is communicated by connected edges and accessible modes. On sufficiently large scales, a local source can generate an approximately spherical response if the effective coefficients become isotropic. Cubic symmetry alone does not make propagation exactly direction independent at every wavelength. That issue can be examined directly rather than hidden in a drawing of a regular lattice.

A nearest-neighbour scalar oscillator lattice provides an elementary transport calculation. For a massless branch with spacing ℓ and a reference wave speed c, its dispersion relation is:

$$\omega^2 = \frac{4c^2}{\ell^2}\sum_{a=1}^{3} \sin^2(\frac{k_a\ell}{2}).$$

When every component $k_a\ell$ is small, the leading term is $\omega^2 = c^2|k|^2$. The next term is proportional to $-\ell^2\Sigma_a k_a^4$ and reveals directional dependence. The group-speed magnitude of this branch is bounded by c, while approaching c in the long-wavelength limit. This calculation supports the possibility of a finite propagation scale in a cell model. It is a scalar transport example; electromagnetic polarization and the identification of the branch with the photon require the corresponding field degrees of freedom.

The proposed universal speed is therefore a target of the collective dynamics. Different stable matter configurations and electromagnetic modes must share the appropriate low-energy limiting behaviour. A nearest-neighbour rule fixes neither that universality nor exact Lorentz symmetry automatically. Taking the microscopic scale to be ℓ_{Pl} can make long-wavelength corrections small in a specified dispersion law, but their coefficients, couplings, and possible preferred-frame effects still matter. The model's claim of compatibility with precision experiments must be assessed from those quantities.

Small breaks add a second form of dynamics. An edge can fail under sufficient load while neighbouring cells remain structurally supported by other connections. Its endpoints can move, oscillate, and reconnect to compatible nearby endpoints. Reconnection changes the local graph; merely reducing and increasing one coefficient on an unchanged graph would not describe migration to a new neighbour. A simulation must therefore store endpoint positions or an equivalent adjacency update, as well as the state of each surviving cell.

An energy threshold provides a simple fracture rule. If $E_{break,e}$ is the work required to break the edge under the specified conditions, a candidate tensile failure condition is:

$$\varepsilon_e + \zeta\nu_e > 0, \qquad E_e \geq E_{break,e}.$$

The threshold defines an effective critical extension. It does not identify the scalar gravitational potential with a mechanical force or strain. Compression, shear, and torsion can require different failure criteria. In a many-edge configuration, a break also redistributes loading, so the first failed edge can either relieve the disturbance or initiate further failure. The energetics of the entire local arrangement, including the cost of newly exposed interfaces, determines whether a crack grows.

Repair competes with growth. The central LTT postulate is that isolated microscopic defects have a strong tendency to close through local oscillation and reconnection, whereas sustained collective overload can prevent closure over a larger region. A healing rule must state which endpoints are compatible, what geometry permits reconnection, and where the associated energy goes. Fast repair cannot be assumed to create energy or to delete the kinetic motion of the endpoints. In a dissipative effective description, the removed mechanical energy must appear in unresolved modes or in the higher-dimensional sector.

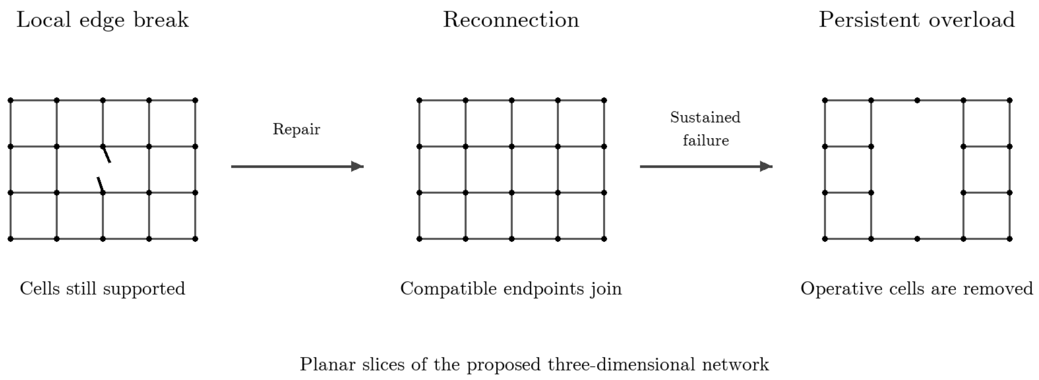

Figure 2. Proposed competition between local repair and collective rupture. A broken edge can reconnect while an enclosure remains operative. Sustained loss of the connections needed to enclose a cluster instead removes cells from the accessible domain. The sequence is schematic and does not represent a simulated collapse.

Finite carrying capacity and elastic failure thus play different roles. Capacity limits which packet states a cell can sustain or transmit. Failure limits the integrity of the enclosure under its combined loading. Their thresholds may be related by the microscopic interaction, but one cannot infer that relationship from dimensional labels alone. The distinction is useful near a compact object: a cell may redirect or transfer excitation before it fractures, while a sufficiently strong collective load may fracture otherwise modestly occupied cells.

4 A VARIATIONAL TENSION EQUATION

The coarse-grained field is introduced to describe the intact network on scales large compared with ℓ. We use s for a dimensionless gravitational loading potential and define the weak-field potential Φ by $\Phi = -c^2 s$. Thus a positive compact source has s greater than zero and decreasing outward, while a slowly moving test configuration has acceleration $a = c^2 \nabla s$. This convention makes the attractive direction explicit. Mechanical edge forces remain F_e, and their failure threshold is not denoted by s.

The nonlinear term in the earliest LTT equation expressed a field-dependent elastic response. We retain that structure through a coefficient K(s). On the positive-load branch, the simplest first-order choice is $K(s) = 1 + \alpha s/s_0$, where s_0 is dimensionless and α is positive. The approximation describes an increasing stiffness with load. It is meaningful only where K is positive and where a scalar continuum response adequately represents the connected network. It is not extrapolated through a region in which the cells no longer exist.

Let $\Omega(\tau)$ denote the operative three-dimensional domain. For a fixed domain during a smooth interval of evolution, define $C = c^4/(4\pi G)$, with units of energy per length. A candidate effective action is:

$$S_s = \int d\tau \int_{\Omega} d^3x \{\frac{C}{2}[\frac{(\partial_\tau s)^2}{c_s^2} - K(s)|\nabla s|^2] + c^2 \rho_Q s\}.$$

Here c_s is the reference speed of the scalar response and ρ_Q is the coarse-grained accessible source density in mass units. At the simplest level it is obtained by averaging occupied-configuration energies and dividing by c^2. The normalization C is chosen to reproduce the measured Newtonian coupling in the weak-field limit; this is a calibration, not a derivation of G from the cell architecture. The coupling of elastic self-energy and other stresses requires a fuller completion. The displayed source can be treated as prescribed for a static calculation, while a dynamical closed model must evolve the matter and exchange sectors as well.

The potential s is dimensionless, ∇s has units of inverse length, and every term in the integrand has units of energy density. The action integral uses ordinary volume and the universal ordering parameter τ. These identifications resolve the ambiguity that arises if one symbol is used alternately for a dimensionless potential, an acceleration potential, and an edge tension. The variables describe connected physics, but they have different units and different operational definitions.

Varying s gives the effective master equation:

$$\frac{1}{c_s^2}\partial_\tau^2 s - \nabla \cdot (K(s)\nabla s) + \frac{K'(s)}{2}|\nabla s|^2 = \frac{4\pi G}{c^2}\rho_Q.$$

For the linear constitutive coefficient, the same equation can be displayed in the form closest to the original nonlinear proposal:

$$\frac{1}{c_s^2}\partial_\tau^2 s - \nabla^2 s = \frac{\alpha}{s_0}\nabla \cdot (s\nabla s) - \frac{\alpha}{2s_0}|\nabla s|^2 + \frac{4\pi G}{c^2}\rho_Q.$$

The additional gradient-square term is required because K depends on the field being varied. Its coefficient is fixed by the action. Dropping it while retaining the stated elastic energy would give a different model. This is a correction within the original load-dependent elastic construction, not an adoption of a MOND interpolation function or another gravitational field law. More elaborate elastic coefficients can be studied using the same variational form once their microscopic meaning is specified.

The earlier suggestion of a shear or torsion contribution can be accommodated only by giving those deformations their own variables and couplings. A scalar source named "shear" does not establish a tensor propagation sector. We therefore retain the scalar master equation for the response it actually describes. Elastic rotations, transverse collective modes, and their coupling to radiation belong to the tensor completion of the network dynamics. Leaving their equations explicit as future work is preferable to treating an undefined term as a calculation of observed gravitational-wave polarizations.

A discrete energy makes the continuum equation less detached from the cells. For a regular cell-centred representation, count each intact neighbour pair once and set $s_{ij} = (s_i + s_j)/2$. A midpoint discretization of the field-gradient energy is:

$$E_s = \frac{C\ell}{2}\sum_{\langle ij\rangle} b_{ij}K(s_{ij})(s_i - s_j)^2.$$

With kinetic energy $C\ell^3 \sum_i(\partial_\tau s_i)^2/(2c_s^2)$, variation yields a second-order evolution equation at each operative cell:

$$\frac{C\ell^3}{c_s^2}\partial_\tau^2 s_i = -\frac{\partial E_s}{\partial s_i} + c^2 m_i, \qquad m_i = \rho_{Q,i}\ell^3.$$

The pairwise derivative includes the derivative of the midpoint coefficient. Consequently the continuum limit contains the same gradient-square correction as the action above. On a fixed graph with fixed sources, the corresponding total energy, including the source interaction, is conserved. If the graph changes, the energy released by the removed connections has to be transferred to the fracture and exchange sectors. The discrete equation does not authorize erasing that energy by deleting a matrix element.

In the static weak-field regime, K approaches one and its nonlinear correction becomes negligible. The result is $\nabla^2 s = -4\pi G\rho_Q/c^2$. With $\Phi = -c^2 s$, this becomes the Newtonian Poisson equation and a positive isolated source produces inward acceleration. This is the first controlled macroscopic limit of the proposed action. It tests the normalization and attractive-force convention, without establishing the relativistic behaviour of light or the post-Newtonian dynamics of a two-body system.

The intact spherical vacuum also has an exact solution for the stated constitutive law. Put $a = \alpha/s_0$ and introduce w(s) by $dw/ds = \sqrt{K}$. Taking $w(0) = 0$ gives:

$$w(s) = \frac{2}{3a}[(1 + as)^{3/2} - 1], \qquad \nabla^2 w = 0.$$

For a spherical exterior approaching the reference state at infinity, $w = \mu/r$ with μ positive. Define the asymptotically measured gravitational mass by $\mu = GM_\infty/c^2$. Inverting w gives:

$$s(r) = \frac{1}{a}[(1 + \frac{3a\mu}{2r})^{2/3} - 1], \qquad g(r) = \frac{GM_\infty}{r^2\sqrt{1 + as(r)}}.$$

This branch is attractive and tends to the inverse-square law at large radius. The first terms are $s = \mu/r - a\mu^2/(4r^2)$ plus higher orders. For positive a, the intact stiffness increase weakens the acceleration relative to the Newtonian value at fixed asymptotic mass. The solution is therefore a useful analytical benchmark, but it does not generate a flat rotation curve in the far exterior. A logarithmic galactic branch cannot be claimed solely from the presence of the nonlinear term.

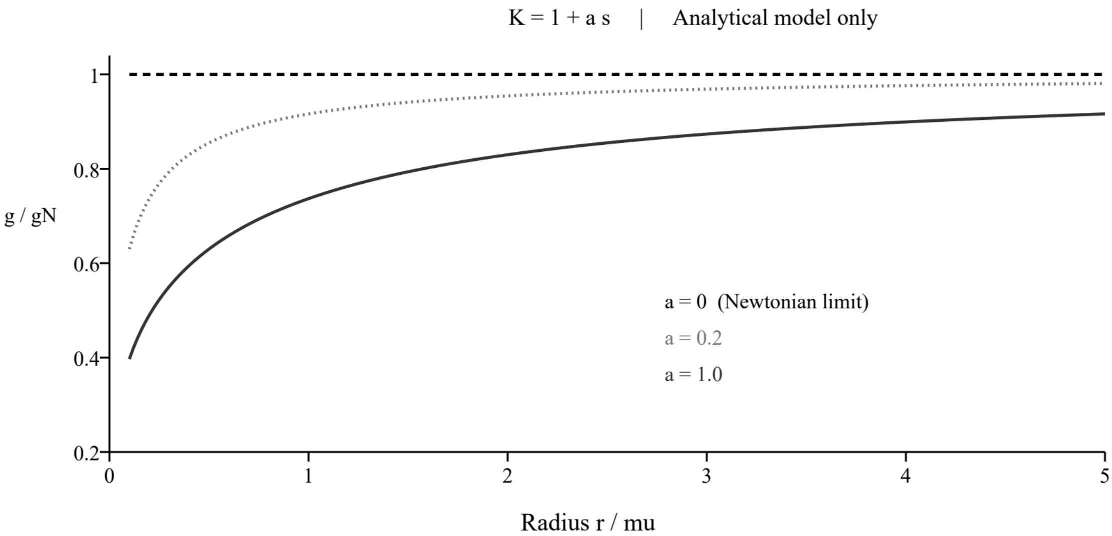

Figure 3. Analytical benchmark for the intact spherical model with K(s) = 1 + as. The acceleration is normalized to the Newtonian value at the same asymptotic mass; radius is measured in units of $\mu = GM_\infty/c^2$. These dimensionless curves illustrate the constitutive response; they are not galaxy fits or observational data.

The source equation in the transformed variable is $\nabla^2 w = -\frac{4\pi G}{c^2}\frac{\rho_Q}{\sqrt{K}}$. This makes a further issue visible: outside the weak-field limit, the asymptotic mass is related to a weighted source integral, not automatically to the unweighted packet count. A self-consistent theory must connect the measured gravitational mass, the energy of a configuration, and its inertial response. The present scalar model fixes one part of that connection and identifies where the remaining dynamics enters.

For galaxies, the model must be extended or evaluated in its actual physical setting: distributed sources, collective phase structure, bulk exchange, and possible long-lived changes of connectivity. A generalization is useful only if it produces those effects with common parameters and conserved energy. Adding a radial source separately for each galaxy would reconstruct the required force rather than predict it. The companion empirical study should therefore distinguish tests of an earlier phenomenological curve from tests of the variational master equation introduced here.

5 SPATIAL RUPTURE AND THE GRAVITATING BOUNDARY

The strong-loading hypothesis concerns the existence of the cells themselves. While the surrounding network can redistribute a local load, it may keep enough edges connected to preserve the enclosed cells. In that regime, small breaks are defects within an operative space. When a cluster loses the connections necessary to maintain its enclosures and cannot repair them under continuing load, it ceases to belong to Ω. The resulting region V is a spatial rupture. A background coordinate label can still locate V in a calculation, but no ordinary cell field is evolved in its interior.

The absolute void is thus defined relative to the three-dimensional cellular sector. It has no accessible cell enclosure, no intercell propagation path, and no ordinary matter configuration supported by such cells. The higher-dimensional arena is not thereby removed. It can retain degrees of freedom and provide routes of exchange at the surviving boundary. This definition preserves the original distinction between empty interiors bounded by a lattice and a hole where the enclosing lattice has itself been lost.

The paper-and-pencil analogy makes the distinction visible. A sheet represents an operative two-dimensional world. A pencil touching it can leave a mark, just as an interaction with a higher-dimensional object can create a lower-dimensional appearance. Increasing the mechanical load beyond the sheet's resistance tears it. The resulting hole is an absence of the sheet, not an unmarked part of it. A pencil in the larger space can pass through the hole, approach from the other side, or touch the surviving boundary and leave a new mark. What a confined observer can register depends on where the supporting sheet remains.

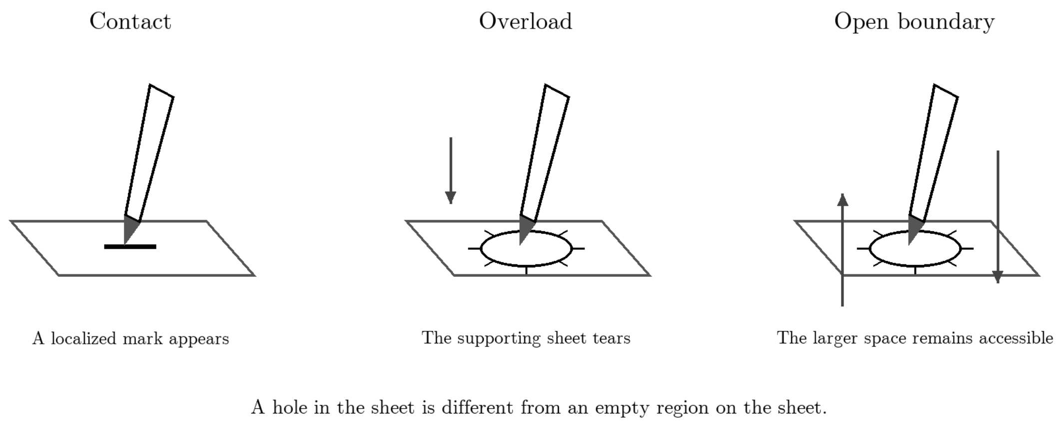

Figure 4. The paper-and-pencil analogy. Contact represents localized access to a higher-dimensional process. Overload tears the supporting sheet. Subsequent interaction is possible through the opening and at the surviving boundary. The drawing is an analogy for the LTT postulates, not a geometrical proof of a black-hole spacetime.

Applied to ordinary space, the proposal identifies a black hole with a persistent three-dimensional rupture and its boundary state. It does not put an ordinary point mass at the centre of the missing network. The energy that formed the object must instead reside in surviving boundary excitation and elastic loading, in outgoing radiation, or in the coupled higher-dimensional sector. The observed gravitational influence is attributed to the boundary response. This is a specific physical hypothesis that requires both an energy account and an exterior field solution.

A simple surface-source construction shows how an empty interior can coexist with an attractive exterior in the scalar model. Let Γ be the boundary of an excised region, and let σ_Γ denote its effective gravitational source per area in mass units. For a static spherical example the exterior domain is r greater than R. Add a surface coupling $c^2 \int_\Gamma \sigma_\Gamma s\, dA$ to the action. Variation gives a boundary condition with n directed outward from the exterior domain, hence toward the cavity at its inner boundary:

$$K(s)\,\mathbf{n}\cdot\nabla s = \frac{4\pi G}{c^2}\sigma_\Gamma.$$

In the weak-field limit this is $-s'(R) = 4\pi G\sigma_\Gamma/c^2$. A harmonic exterior $s = \mu/r$ therefore has $M_\infty = 4\pi R^2\sigma_\Gamma$ and attracts ordinary test configurations, even though the excised region contains no volume source. This demonstrates the mathematical possibility of a boundary-sourced exterior within the stated scalar action. It does not establish that gravitational collapse produces the assumed surface source or that its strong-field exterior agrees with observations.

For the nonlinear spherical solution in Section 4, the same boundary condition gives:

$$M_\infty = \frac{4\pi R^2\sigma_\Gamma}{\sqrt{K(s_R)}}, \qquad s_R = s(R).$$

The source density σ_Γ must be computed from the boundary state. Equating it to boundary energy divided by c^2 is a weak-field identification to be tested in a more complete theory. The nonlinear weighting already shows that a simple unqualified equality between total local energy and asymptotic gravitational mass is insufficient. A dynamical surface action would also provide tangential stresses and the equation governing R. The boundary condition alone supplies the exterior response but not an equilibrium radius.

The size of a rupture is consequently to be determined by energy, connectivity, and critical loading, rather than assigned by placing a central material mass in the hole. Nevertheless, the measured exterior mass remains an observable that the resulting radius must be related to. If identical saturated boundary cells supplied a constant surface energy density, their total energy would grow as R^2. The inferred weak-field mass would then also scale as R^2. That is a calculable implication of this simple boundary assumption, and it is not automatically the familiar linear mass–radius scaling of a relativistic horizon. The distinction must be resolved by the complete boundary dynamics and observations.

Failure also requires a consistent event balance. Write E_{before} for the energy of a local region immediately before an edge or cell update. After the update, account for the surviving configuration, the new interface, emitted accessible modes, and the higher-dimensional recipient. For a closed local accounting volume with fluxes included, their sum must equal E_{before}. The threshold rule determines when a change is energetically admissible; it does not choose the partition of the released energy. The partition is part of the microscopic transition law.

This requirement is especially important for the claim of a singularity-free description. Removing the cell domain prevents continued use of an intact continuum formula in that region. To establish a nonsingular physical evolution, the remaining state variables, boundary forces, and energy fluxes must also stay controlled or be replaced by a specified finite microscopic evolution. A clipping operation on a divergent field would not establish that result. LTT proposes a physical replacement mechanism, and a collapse calculation must determine whether that mechanism actually succeeds.

Small defects can reconnect because the surrounding cells remain available to guide the endpoints back into compatible arrangements. A macroscopic rupture may persist because the boundary load continually prevents closure, because its topology restricts repair, or because exchange maintains the disturbed boundary state. These possibilities lead to different lifetimes and responses to perturbation. The present paper retains the original repair hypothesis without prescribing a universal permanence rule for every crack. A stable compact object is a solution to find, not a label attached to any broken edge.

Within this picture, the edge elasticity, packet configuration, and boundary source are inseparable. An exterior field calculated from an arbitrary surface density would be only a partial construction. The distinctive LTT task is to derive that density and the interface dynamics from the same loaded cells that create ordinary matter and gravity. This would connect the observable mass of a compact object to its formation history and microscopic support, while preserving an interior without ordinary three-dimensional cells.

6 LIGHT BOUNDARY EXCHANGE AND RADIATION

A photon is hypothesized to be a propagating QEP configuration that uses the operative cell network. Where the network is absent, that ordinary intercell propagation channel is absent as well. In this sense, light cannot enter the absolute void as a continuing three-dimensional photon. This statement concerns the material carrier of the signal. It is different from saying that the incident energy disappears, and it does not by itself specify what an external observer sees when light reaches the boundary.

There are several possible destinations for that incident energy within the proposed ontology. It can remain in the boundary as an excitation, transfer into other accessible modes, be reflected, or couple to the higher-dimensional sector. Their relative rates must be determined by the boundary interaction. The idea that the interior lacks a photon channel is compatible with external absorption if incident photon energy is converted at the boundary. It need not imply a bright reflecting surface. Conversely, a strongly reflecting boundary would have observational consequences that must be calculated rather than omitted.

The original picture associates tightly constrained photon and QEP paths with the loaded region surrounding the hole. A nonuniform propagation law can bend trajectories, and an appropriate radial profile can admit a circular ray orbit. For an isotropic, static refractive description $n(r)$, the circular-ray condition is $d[rn(r)]/dr = 0$. This is a geometrical-optics condition to apply after the effective refractive index has been derived. It does not determine n from the scalar master equation alone, and a circular ray orbit is not itself an event horizon.

A horizon is a statement about the global escape of signals, whereas rupture is a statement about the existence of their local support. The theory proposes a physical relationship between the two. Establishing that relationship requires the time-dependent propagation of every accessible channel and the boundary exchange law. A scalar mode travelling at c_s cannot stand in for electromagnetic and tensor gravitational modes without their dynamics. The proposed black-hole identification therefore contains a further causal problem beyond the surface-source calculation in the preceding section.

The higher-dimensional sector gives a concrete location for an alternative microscopic radiation mechanism. Strongly disturbed boundary cells can exchange excitation with modes unavailable in ordinary intact regions. Some transfers can populate outgoing accessible modes. In LTT this is the proposed origin of black-hole radiation: higher-dimensional exchange mediated by the surviving boundary. Its strength should depend on the boundary state and on the energy mismatch and coupling between the participating modes.

A useful phenomenological representation of the emitted spectral power is a sum over boundary elements:

$$\frac{dP_{out}}{d\omega} = \sum\nolimits_{a\in\Gamma} \hbar\omega\, \mathcal{J}_a(\omega).$$

Here $J_a(\omega)d\omega$ is the number of outward quanta produced per unit universal time in the frequency interval $d\omega$ at element a. It must be obtained from the exchange Hamiltonian, mode populations, and transmission probabilities. The formula records energy carried by emitted quanta; it does not assume a thermal spectrum. To reproduce a Hawking-like law, the dynamics must generate the appropriate frequency dependence, temperature scaling, and exterior transmission factors [5]. A thermal factor cannot be inserted and then cited as a derivation of thermality.

Energy emission should change the state that sources the exterior field. For a chosen boundary control region, a balance has the schematic form:

$$\frac{dE_\Gamma}{d\tau} = P_{in,3} + P_{in,4} - P_{out,3} - P_{out,4} + P_{mech}.$$

The subscripts distinguish accessible and higher-dimensional channels, and P_{mech} is work done on the boundary by the surrounding network. If the control surface moves, the definitions must include advective transport. This equation is a conservation requirement for an eventual radiation calculation. It explains why continuing emission cannot leave a finite, isolated boundary state unchanged unless another channel replenishes it.

The surface also provides a natural setting for the original entropy idea. If the active microscopic states are concentrated in a layer of fixed thickness near the boundary, their leading count can scale with its area. For the simplest independent-element illustration, suppose that $N_\Gamma = \xi A/\ell^2$ effective boundary elements each have g admissible states. Then:

$$S_\Gamma = k_B \ln(g^{N_\Gamma}) = \xi k_B \ln(g)\,\frac{A}{\ell^2}.$$

This is a conditional area law. The factor ξ includes the counting convention and geometry, and independence is an approximation. Correlations and conservation constraints can change the count. With $\ell = \ell_{Pl}$, reproducing the semiclassical coefficient would require $\xi\ln(g) = 1/4$, not merely the presence of an area in the formula. The known black-hole entropy law is a theoretical target for the microscopic model [6]; this counting example does not establish its coefficient or an observed microscopic entropy.

Information can likewise be redistributed among sectors. An observer restricted to surviving three-dimensional cells may no longer access correlations carried into the bulk or stored in the boundary. If the full evolution is unitary, tracing over inaccessible degrees of freedom gives an apparently mixed accessible state without destroying the joint information. The model proposes this as the meaning of information leaving the observable description. A proof of information preservation still requires a complete evolution through fracture, exchange, and repair, rather than unitary evolution only between graph-changing events.

The boundary interpretation is therefore more specific than a general appeal to additional dimensions. It assigns three tasks to the same surviving structure: carrying the exterior gravitational source, handling incident excitation when no interior cell path exists, and mediating outward radiation. A successful compact-object solution must make these tasks compatible. The absence of ordinary matter inside the void is preserved as a postulate, while the observable consequences are determined by what the boundary actually does.

7 UNIVERSAL TIME AND COLLECTIVE COSMIC EVOLUTION

The time proposal begins with the role of physical change in measurement. A clock does not display an abstract parameter directly; it counts reproducible transitions. In a cellular description, those transitions depend on the transmission, reorganization, and interaction of accessible excitations. If loading changes these processes, identical clock mechanisms placed in different network conditions may accumulate different readings. LTT interprets such differences as changes in the clocks and their material dynamics.

We adopt a universal ordering parameter τ once a changing physical system exists. It is independent of the number of spatial dimensions and is not identified with the fourth spatial coordinate. In the pre-spatial, matter-free state imagined by the proposal, no operative process defines a measured duration. Calling time emergent in this operational sense is compatible with postulating a common ordering for the subsequent dynamics. It is not a deduction that a unique universal time can already be reconstructed from arbitrary clocks.

Let t_{read} be the reading of a specified clock, calibrated in the unstrained reference state. Its relation to universal ordering can be represented by:

$$dt_{read} = R(s, \nu, \mathbf{v}, C)\, d\tau.$$

The positive response R may depend on local load, occupation, velocity relative to the network, and the clock configuration C. This formula expresses the proposed distinction between time and the rate of material change. It does not fix the function R. Explaining the common behaviour of different clock technologies requires deriving that response from their interactions rather than fitting a separate rate law to each device.

The mechanism envisaged in the original draft is increased resistance to information transfer under strained intercell connections. A transition that normally requires a sequence of transfers can then take more universal time to complete. An illustrative clock consisting of m sequential transfer steps with a characteristic rate Γ has a period proportional to m/Γ. Reducing Γ slows its reading. This is a simple kinetic example of the interpretation, not a derivation of the relativistic clock formula for arbitrary motion or gravity.

Motion can modify the same microscopic processes because a moving configuration is continually reconstructed across new cells. The original proposal attributes changes in its internal behaviour to the opposition or response of the carrier network. Such an interaction need not be modelled as ordinary dissipative friction: persistent uniform motion requires that any exchange be compatible with the observed stability of freely moving matter. A model that produces an unobserved steady loss of kinetic energy would fail even if it slowed a clock in the desired direction.

The universal-time interpretation becomes experimentally distinct only when its dynamics predicts a measurable difference from relativistic descriptions. If it reproduces every accessible relation between clocks and signals, the difference could remain interpretational. If it predicts a preferred direction, velocity dependence, or composition dependence, that prediction is constrained by precision experiments [7]. The present article states the postulate and its proposed material mechanism. A subsequent study must derive the clock response and compare it with measurements without assuming the conclusion in advance.

This treatment also keeps the discussion of time in quantum mechanics in its proper role. Tying clock readings to transitions motivates a relational account of measurement. It does not, on its own, explain every mathematical issue associated with time observables or replace the evolution law for the full system. The theory needs a definite rule for changes ordered by τ, including exchange events and graph updates. The distinction between an ordering parameter and a physical clock is part of that rule's interpretation.

The cosmological proposal applies the same network language to much larger scales. Resonances generated by occupied regions weaken or change their mutual coherence with separation. The author proposes that a changing balance of these collective interactions can favour the separation of large structures and contribute to cosmic expansion. Motion toward less constrained regions is a local intuition for that response. A homogeneous expansion, however, must be described by a collective evolution of separations rather than by choosing an external empty direction for every galaxy.

There is also a geometrical issue to specify. If the reference cell size is fixed, increasing macroscopic distances can involve strain, the formation of additional cells, a change in connectivity, or some combination of these processes. These possibilities are physically different. Cell formation would exchange energy with the larger sector, while sustained strain would alter the reference-state approximation. A cosmological implementation must choose and evolve those variables, define how light measures the resulting distances, and connect the evolution to redshift and structure formation.

The first article therefore retains resonance weakening as the proposed origin to investigate, without identifying it with a calculated expansion history. No Hubble parameter, cosmic microwave background spectrum, or large-scale growth curve is derived here. Those observables require a homogeneous background solution and its perturbations. The common physical aim is to describe changes of matter, clocks, and large-scale separation through one evolving carrier network, while keeping their distinct measurements and equations explicit.

8 CONSEQUENCES AND A PROGRAMME OF TESTS

The most immediate result of the formulation is a consistent separation of physical roles. Packet occupation supplies accessible excitation; elastic edges store and transmit load; connection updates permit repair; cell removal defines a spatial rupture; and its boundary remains an active source and exchange region. The scalar master equation describes a connected-domain limit of that system. Its derivation is a mathematical result of a specified action, while the interpretation of the action as a description of space is the physical hypothesis under investigation.

Several calculations can already be checked without claiming observational success. The attractive weak-field limit follows from the source normalization and force convention. The spherical exterior solves the static variational equation. The pairwise discrete energy reproduces the corresponding continuum gradient structure. The surface coupling permits an attractive field outside an excised, matter-free region. The conditional entropy count gives an area dependence when the microscopic state assumptions are imposed. Each result has explicit assumptions and can be tested independently of the more ambitious claim that all known physics emerges from the network.

The mathematical checks accompanying this formulation evaluate directional variations of the discrete energy, the continuum field residual, and the boundary flux of the analytical spherical solution. They also examine the long-wavelength transport limit. These calculations test consistency between the displayed equations. They do not fit telescope data or evolve the formation of a black hole. Keeping their scope explicit prevents a successful algebraic check from being counted as a passed observational test.

For galactic dynamics, the central target is the spatial response produced by one common network law across different source distributions. The SPARC database supplies resolved rotation curves and baryonic mass models for such an investigation [8]. Comparisons with MOND and with gravity models including dark matter must use consistent data choices, uncertainty treatment, and parameter accounting. The earlier numerical study concerns a phenomenological rotation prescription; its fit statistics are not transferred to the new variational action. A second article can report those results and distinguish them from a subsequent direct solution of the master equation.

The exact intact solution is particularly useful in preparing that comparison. It shows that the simplest positive linear stiffness law does not produce a flat far-field curve around a compact source. Consequently the explanatory work must be done by a specified additional physical ingredient already motivated by the theory, such as extended source structure, collective phase dynamics, exchange, or evolving connectivity. The ingredient must be derived or independently constrained. A galaxy-by-galaxy choice that merely reproduces the desired profile would not establish an advantage over competing models.

Local gravity provides an equally necessary comparison. The Newtonian limit is only the first requirement. Light deflection, gravitational frequency shifts, signal delay, orbital precession, and binary dynamics require the appropriate matter and light equations in the effective medium. An assumed metric can serve as a provisional transport model, but results obtained from it must be labelled as conditional on that assumption. They cannot establish that the microscopic cell dynamics has already reproduced the metric. The scalar master equation presented here does not by itself supply all post-Newtonian parameters.

Compact objects test both the boundary and the propagation law. EHT measurements of Sagittarius A* constrain strong-field image properties and possible deviations from conventional black-hole models [9]. The relevant comparison is an observable image or ray-scattering quantity calculated using the same source and transport model, rather than a coordinate radius quoted in isolation. In particular, the cell-free cavity radius, a circular photon orbit, the critical impact parameter, and the observed emission ring are distinct quantities that a completed calculation must relate.

Gravitational-wave data supply another set of conditions. Analyses of the GWTC-3 events found no significant evidence for the tested departures from general relativity [10]. The network must therefore derive the relevant tensor modes, their generation, propagation, and interaction with a rupture boundary before making a comparable prediction. An additional scalar channel must have an allowed coupling or be sufficiently suppressed in the regimes already tested. The statement that a scalar wave travels at a chosen speed c is not equivalent to a successful binary-waveform calculation.

The theory's most characteristic future calculation is the formation and response of a cell-free region. Starting from specified packet configurations, edge energies, and exchange laws, one should evolve fracture and repair, determine the surviving boundary state, and compute its exterior field. That calculation could establish whether the proposed transition avoids an uncontrolled continuum endpoint and whether it produces a stable object. Incident light and perturbations could then be propagated through the exterior and into the boundary interaction to predict absorption, reflection, or delayed response.

The first article provides the assumptions and equations needed to begin that programme, while keeping its physical picture intact. The empirical galaxy article, the study of clock dynamics under universal ordering, and the compact-object article address different unresolved links. They should use compatible definitions and retain unsuccessful tests as constraints on the model. A useful theory develops through those constraints: it must explain the observations that motivated it and remain consistent with the observations it was not designed to fit.

9 CONCLUSION

Lattice Tension Theory proposes a cellular origin for observable space and matter. Cubic enclosures receive quantum energy packets from a four-spatial-dimensional arena, and persistent packet configurations form accessible matter. Occupation loads elastic edges; coupled disturbances generate the collective response identified with gravitation. Local defects can repair through reconnection, while sustained overload can remove the cellular structure over a region. A black hole is proposed to be this cell-free region together with its gravitating and radiating boundary.

The mathematical construction preserves these distinctions. An occupation balance describes transfer, an edge energy makes loading and failure explicit, and a variational scalar equation describes the intact gravitational response. A boundary source can support an attractive exterior without a central volume source. The energy released by fracture, the destination of incident photons, and the production of outward radiation remain part of the same conservation problem. Universal time is retained as an ordering postulate, with clock readings determined by material transition rates.

The contribution is a physically specified starting theory with conditional derivations, rather than a list of claimed successes. The next steps are to close the microscopic exchange and repair rules, derive the observable matter and radiation channels, and solve the resulting systems against data. Those calculations will determine whether the proposed common origin of matter, gravitation, and spatial rupture provides a successful description of nature.

APPENDIX MATHEMATICAL DETAILS

For the scalar action, the derivative of the gradient term with respect to s is $-CK'|\nabla s|^2/2$. Its spatial Euler–Lagrange contribution is $C\nabla\cdot(K\nabla s)$, and the kinetic contribution is $-C\partial^2_{\tau s}/c_s^2$. Including the source $c^2\rho_Q$ and dividing by C gives the master equation in Section 4. The static equation is $K\nabla^2 s + K'|\nabla s|^2/2 = -\varkappa\rho_Q$ with $\varkappa = 4\pi G/c^2$. Defining w by $w'(s) = \sqrt{K}$ then gives $\nabla^2 w = -\kappa\rho_Q/\sqrt{K}$. This transformation applies on a positive-K branch and does not define a continuation through a missing-cell region.

For an intact neighbour pair, define $\Delta_{ij} = s_i - s_j$ and $K_{ij} = K[(s_i + s_j)/2]$. Differentiating its energy gives the pair contribution $C\ell b_{ij}[K_{ij\Delta ij} + K'_{ij\Delta ij}{}^2/4]$ to $\partial E_s/\partial s_i$. The derivative at j has the opposite linear term and the same coefficient-derivative term. Expanding the six-neighbour expression for a smooth field yields the static energy gradient $-C\ell^3[K\nabla^2 s + K'|\nabla s|^2/2]$ at leading order. The nonlinear coefficient is therefore consistent between the lattice energy and the continuum action.

The coefficient C has units J m⁻¹, so $C\ell(s_i - s_j)^2$ is an energy and $C\ell^3(\partial_{\tau si})^2/c_s^2$ is also an energy. A source mass m_i couples through $-c^2 m_i\, s_i$ in the Hamiltonian. On a fixed graph with time-independent sources, the kinetic, gradient, and source-interaction energies together are conserved by the equations of motion. The positive gradient energy should not be confused with a claim that the full gravitational system, including arbitrary prescribed sources, is globally bounded below.

For $K = 1 + as$, the vacuum solution satisfies $\sqrt{K}s' = -\mu/r^2$. It follows immediately that $g = -c^2s'$ is positive on the attractive branch and that $g/g_N = [1 + 3a\mu/(2r)]^{-1/3}$. The a approaching zero limit is smooth and gives $s = \mu/r$. The nonlinear branch remains a connected-domain solution. It neither selects a rupture radius nor supplies a flattened galactic rotation curve at large radius.

Variation of the bulk gradient action produces the boundary term $-C\int_\Gamma K(n\cdot\nabla s)\delta s\, dA$. Adding the specified surface coupling gives the boundary condition in Section 5. For an inner spherical boundary, $n = -e_r$; hence $K(-s') = \varkappa\sigma_\Gamma$. Substituting the exact solution yields $\mu\sqrt{K_R}/R^2 = \kappa\sigma_\Gamma$ and therefore the stated relation between asymptotic mass and surface source. The sign of the inner normal is essential for obtaining an attractive exterior from a positive boundary source.

For the transport example, differentiation of the dispersion relation gives $v_a = c^2\sin(k_a\ell)/(\omega\ell)$. Since $\sin^2(k_a\ell)$ is at most four $\sin^2(k_a\ell/2)$, the sum of the squared group-velocity components is at most c^2 for the massless branch. Expanding the sine functions at small $k\ell$ gives the isotropic leading term and direction-dependent corrections of order $(k\ell)^2$ in the phase speed. Neither this bound nor the scalar dispersion establishes the spin or gauge symmetry of electromagnetism.

The fracture threshold gives a critical tensile extension $\varepsilon_e + \zeta\nu_e = \sqrt{2E_{break,e}/(k_e\ell^2)}$ in the isolated-edge approximation. A connected network changes this local calculation because a break redistributes forces and creates an interface. A simulation must specify which failed configurations retire cells, how energy is partitioned at retirement, and how new enclosures are admitted during repair. These are transition rules in addition to the smooth field equations. No rule of instantaneous deletion is used here as a proof of energy conservation or singularity avoidance.

Data and computational scope. SPARC data are available at https://astroweb.case.edu/SPARC/. The calculations reported in this article are analytical model results and numerical consistency checks. Galaxy-level comparisons are reserved for a separate article, and no numerical superiority over GR or MOND is claimed for the present action.

Preparation and attribution. The cellular construction, higher-dimensional packet origin, elastic interpretation of gravity, universal-time interpretation, and spatial-rupture picture originate in the author's LTT proposal. AI-assisted tools contributed to mathematical formulation, consistency checking, literature searches, writing, and document preparation. The author is responsible for the final scientific claims. Established mathematical methods and external observational results are attributed below; historical priority for the proposed combined model has not been established by this article.

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