Show Me the Mathematics

Beginning the Mathematical Exploration of SpacePressure

This page is an optional deeper path from Chapter 3 — Starting the Formalising Process.
The conceptual question has already been asked:

Could aspects of spacetime curvature also be interpreted physically as spatial compression and pressure-like response?

At this point, the nature of the question changes.
If SpacePressure is to become more than a visual or conceptual interpretation, it must eventually be connected to mathematics.
It must be shown how the idea of compressed space could sit beside the established equations of Newtonian gravity and General Relativity without contradicting either.

An Important Qualification

I, the author of One Small Change to Gravity — One Giant Leap for Science, am not a mathematician, and I am not presenting a finished mathematical theory of gravity.

This section represents the beginning of an investigation, not its conclusion.

In developing it, I have used AI assistance to help present established gravitational mathematics in an accessible form and to explore possible mathematical bridges between that established physics and the SpacePressure Interpretation.

The distinction is important.

The established mathematics belongs to physics.

The proposed interpretation is SpacePressure.

> Any suggested mathematical connection between them must therefore be treated as provisional until it has been independently examined, formalised and tested by people with the appropriate mathematical and scientific expertise.

What This Page Is Trying to Establish

The purpose is not to invent equations merely to make SpacePressure appear mathematical.

It is to ask a much more disciplined question:

Does the mathematics we already use to describe gravity contain structures from which a physically meaningful concept of spatial compression could legitimately be defined?

That means beginning with what is already established:

- Newtonian gravitational force and potential;
- General Relativity and the Einstein field equations;
- the spacetime metric;
- geodesic motion and geodesic convergence;
- changes in proper distance and spatial volume;
- tidal deformation, expansion and shear.

Only then can we ask whether a compression quantity—or perhaps ultimately something more complex than a single scalar—could be derived from that existing structure.

The mathematics must not be forced to fit the interpretation.

The interpretation must prove that it can fit the mathematics.

Newton: The Mathematics of Gravity

Newtonian gravity describes the attraction between two masses using the inverse-square law:

where:

- F is the gravitational force between the two bodies;
- G is Newton's gravitational constant;
- m_1 and m_2 are the two masses; and
- r is the distance between their centres.

$$F = G\frac{m_1 m_2}{r^2}$$

This equation tells us that the gravitational force becomes stronger as the masses increase and weaker as the distance between them increases.

More precisely, the force decreases with the square of the distance.

For a small body moving near a much larger spherical mass, such as an object near Earth, the gravitational acceleration can be written as:

where:

- g is the gravitational acceleration;
- M is the mass of the larger body; and
- r is the distance from its centre.

$$g = \frac{GM}{r^2}$$

Newtonian gravity can also be written using the gravitational potential, represented by Φ. Around an isolated spherical mass:

$$\Phi = -\frac{GM}{r}$$

The gravitational acceleration is then obtained from the gradient of that potential:

$$\mathbf{g} = -\nabla\Phi$$

This means that objects accelerate in the direction in which the gravitational potential decreases most steeply.

Newtonian gravity may also be expressed through Poisson's equation:

$$\nabla^2\Phi = 4\pi G\rho$$

where:
· ∇^2 is the Laplacian operator;
· Φ is the gravitational potential;
· G is Newton's gravitational constant; and
· ρ is the density of matter.

This equation states that matter density acts as the source of the gravitational potential.

These equations are extraordinarily successful. They predict falling bodies, tides, planetary orbits, and much of the motion of astronomical objects with remarkable accuracy.

But Newton's mathematics primarily describes what gravity does. It does not provide a complete physical account of what gravity is. Newton himself was aware of this limitation. He did not claim to have identified a physical mechanism by which gravity acted across space.
This is one point at which SpacePressure enters the discussion.

How SpacePressure Could Supplement Newton's Mathematics

SpacePressure would not need to change Newton's equations in order to reinterpret them. The standard relationship would remain:

$$\mathbf{g} = -\nabla\Phi$$

In conventional Newtonian language, an object accelerates down the gradient of the gravitational potential.
SpacePressure asks whether the potential Φ might also be associated, in the weak-field limit, with a quantity representing the spatial condition surrounding mass.

Let that tentative compression quantity be denoted by C.
At the simplest conceptual level, one might explore a relationship such as:

$$C \propto -\Phi$$

or, after introducing an appropriate reference scale and ensuring dimensional consistency,

$$C = f(\Phi)$$

where f is a defined function connecting the Newtonian potential to a proposed measure of compression.

At this stage, the expression C = f(Φ) should be understood only as interpretive scaffolding.

If C is defined solely as a monotonic function of the Newtonian gravitational potential Φ, then it does not yet introduce new physical content or produce different predictions. Mathematically, it is equivalent to a relabelling of information already contained in Φ.

Its possible value would therefore not lie in changing Newtonian gravity, but in providing a provisional language for asking whether gravitational potential might later be connected to a more general, geometry-derived measure of spatial compression within General Relativity.

Unless C can eventually be defined in a way that adds genuine mathematical structure, explanatory value, or testable consequences, it should not be treated as a new physical field or as evidence for SpacePressure.
For now, it is a conceptual bridge: a way of connecting the familiar Newtonian potential to the proposed physical interpretation of spatial compression.
The exact relationship cannot simply be assumed. It would need to be chosen or derived carefully.
If C were defined so that its gradient corresponded to the gravitational field, then one could write schematically:

$$\mathbf{g} \propto \nabla C$$

The sign and scale would depend upon the precise definition of C. In this language, matter would move in response to a spatial compression gradient. The Newtonian prediction would remain unchanged. What would change is the proposed physical meaning assigned to the potential.

In the conventional Newtonian description:

Matter creates a gravitational potential, and objects accelerate along its gradient.

In the SpacePressure interpretation:

Matter produces an altered spatial condition, and objects accelerate in response to the gradient of that condition.

This would not prove SpacePressure. But it indicates how the idea might begin to connect with Newton's existing mathematical framework without altering its successful predictions.

Einstein and General Relativity: The Mathematics of Gravity

Einstein's General Relativity superseded the Newtonian picture of gravitational attraction with a deeper geometric description of spacetime, while recovering Newtonian gravity in the appropriate limit.

The central equation is the Einstein field equation:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

where:

- $G_{(\mu\nu)}$ is the Einstein tensor, describing aspects of spacetime curvature;
- Λ is the cosmological constant;
- $g_{(\mu\nu)}$ is the spacetime metric;
- G is Newton's gravitational constant;
- c is the speed of light; and
- $T_{(\mu\nu)}$ is the stress-energy tensor, describing matter, energy, momentum, and pressure.

In simplified language:

Matter and energy shape the geometry of spacetime.

The motion of a freely falling object is described by the geodesic equation:

$$\frac{d^2x^\mu}{d\tau^2} + \Gamma^\mu_{\alpha\beta}\frac{dx^\alpha}{d\tau}\frac{dx^\beta}{d\tau} = 0$$

where x^μ denotes spacetime coordinates, τ is proper time along the path, and Γ^μ_{αβ} denotes the Christoffel symbols derived from the metric.

This equation says that freely falling objects follow the natural paths of curved spacetime.

These paths are called geodesics.

In Newton's description, Earth exerts a gravitational force on a falling apple. In Einstein's description, Earth alters spacetime geometry, and the apple follows a geodesic through that geometry. The metric tensor $g_{(\mu\nu)}$ determines how distances and times are measured in spacetime.

If the metric changes, the measured structure of spacetime changes.

Gravitational time dilation, light bending, black holes, orbital corrections, and gravitational waves all arise from spacetime geometry. General Relativity has been confirmed with extraordinary precision.

Yet a conceptual question remains.

The theory tells us how geometry behaves and how matter moves within it. It does not necessarily provide a simple underlying physical picture of what spacetime itself is or why it possesses those dynamical properties.
This is the opening that SpacePressure explores.

How SpacePressure Could Supplement Einstein's Mathematics

SpacePressure does not require the Einstein field equations to be discarded. The established equation remains:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

In standard General Relativity, this equation is interpreted geometrically.
Matter and energy are associated with spacetime curvature, and curved spacetime determines gravitational motion.
SpacePressure asks whether aspects of that curvature might also be interpreted as spatial compression and pressure-like response.
This would not replace curvature.
It would attempt to give curvature an additional physical meaning. The metric $g_{(\mu\nu)}$ already determines how spatial and temporal intervals are measured. If mass and energy change the metric, they change the measured relationships between distances and times.
In some situations this appears as stretching. In others, it appears as squeezing, convergence, or changes in spatial volume.
This suggests a possible interpretive bridge.
A compression quantity might be derived from the metric, curvature, or the behaviour of families of geodesics.
Schematically, one might write:

$$C(x) = \mathcal{F}[g_{\mu\nu}(x)]$$

where:

- C(x) represents a proposed local compression measure at spacetime point x; and
- F represents a mathematical construction derived from the existing geometry.

This expression is deliberately general.

It does not yet define C.

It states only that any legitimate SpacePressure quantity should arise from established spacetime geometry rather than being added arbitrarily as an unrelated new field.

Newton: The Mathematics of Gravity

- the metric determinant;
- changes in proper spatial volume;
- the expansion scalar;
- shear and tidal quantities;
- curvature scalars;
- selected projections of the Riemann or Ricci tensors; or

- another coordinate-independent geometric measure.

Each possibility presents difficulties.

For example, spacetime curvature cannot generally be represented by one scalar alone. A scalar may capture only one limited feature of a richer tensorial geometry.

Therefore, the introduction of C should be treated as a tentative mathematical direction, not as a completed definition. In the weak-field limit, a successful compression quantity would also need to connect with Newtonian gravitational potential.

Schematically:

$$C \longrightarrow f(\Phi) \quad \text{in the weak-field limit}$$

when gravitational fields are weak and velocities are small.

This could provide a bridge between the three descriptions.

In Newtonian language:

$$\mathbf{g} = -\nabla\Phi$$

Objects accelerate along the gradient of gravitational potential.

In Einsteinian language:

Objects follow geodesics in curved spacetime.

In SpacePressure language:

Objects respond to gradients in a geometrically defined spatial condition associated with compression.

These might eventually become three descriptions of the same gravitational behaviour.

The essential point is that Einstein's field equations remain intact. SpacePressure would sit beneath them as a proposed interpretation of what aspects of curvature may physically represent.

In the standard interpretation:

Mass and energy curve spacetime.

In the SpacePressure interpretation:

Mass and energy alter the spatial structure in a way that may be physically interpreted as compression and geometrically described as curvature.

The mathematics remains Einstein's.

The added proposal concerns the physical meaning of the geometry.

SpacePressure: The Beginning of a Mathematical Framework

The formalisation of SpacePressure must begin cautiously.

It should not begin by immediately proposing a new field equation.

It should not add new constants, forces, or particles unless such additions become mathematically necessary and empirically justified.

The first task is to determine whether existing gravitational mathematics can support a compression-based interpretation.

A careful beginning would introduce a tentative compression quantity C derived from known gravitational structure. In the Newtonian limit, C might be related to the gravitational potential:

$$C = f(\Phi)$$

Since Newtonian acceleration is:

$$\mathbf{g} = -\nabla\Phi$$

a suitable definition could allow gravitational motion to be interpreted as motion associated with a compression gradient:

$$\mathbf{g} = k\nabla C$$

where k represents whatever scaling and sign convention follows from the definition of C.
If C increases with the proposed degree of compression, the sign of k must be chosen consistently with the adopted relationship between C and Φ.
This would not change Newtonian predictions.
It would change the proposed physical interpretation.
Within General Relativity, the corresponding idea would be expressed schematically as:

$$C(x) = \mathcal{F}[g_{\mu\nu}, R_{\mu\nu\rho\sigma}, T_{\mu\nu}, \ldots]$$

This indicates that a compression quantity might depend upon the metric, curvature, stress-energy, or related geometric structures.

At this stage, no single definition is being asserted as correct.

A scalar may prove inadequate.

A tensorial description may be necessary.

The concept may need to distinguish between:

- isotropic compression;
- directional contraction;
- shear;
- changes in spatial volume;
- tidal deformation; and
- convergence of worldlines.

The safest statement at this point is therefore:

SpacePressure is not yet a new mathematical theory. It is a proposed interpretive framework seeking to express gravitational curvature as spatial compression and gravitational acceleration as a response to compression gradients.

This gives us three linked descriptions.

Newtonian Description

Gravity is represented as acceleration down a gravitational potential gradient:

$$\mathbf{g} = -\nabla\Phi$$

Einsteinian Description

Gravity is represented as motion through spacetime geometry shaped by matter and energy:

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

SpacePressure Interpretation

A compression quantity is derived from the existing gravitational geometry:

$$C = \mathcal{F}[g_{\mu\nu}, \text{curvature}, \text{geodesic behaviour}]$$

and, in the appropriate weak-field limit:

$$C \longrightarrow f(\Phi) \quad \text{in the weak-field limit}$$

Gravitational motion may then be interpreted as response to gradients in that compression state.

This is not presented as proof.

It is presented as a starting structure.

For SpacePressure to become more than a conceptual interpretation, several further steps would be required:

1. Define the compression quantity precisely.
2. Ensure that the definition is coordinate-independent or clearly tied to physically defined observers.
3. Show how it is derived from the spacetime metric or other accepted geometric quantities.
4. Recover Newtonian gravity in the weak-field limit.
5. Remain consistent with General Relativity in strong fields.
6. Account for gravitational waves, tidal effects, black holes, lensing, and time dilation.
7. Avoid introducing contradictions with established observations.
8. Determine whether the interpretation produces any new explanatory, mathematical, or testable value.

Only then could SpacePressure begin to be considered a serious formal supplement to gravitational theory.

Closing: What Has — and Has Not — Been Established

The mathematics explored here does not prove SpacePressure.

Nor does it establish a new theory of gravity.

What it does is identify a possible route by which the interpretation could be investigated more rigorously.

Newton provides a mathematical description of gravitational force and gravitational potential.

Einstein provides the far deeper geometric description of gravitation through spacetime.

SpacePressure asks whether some aspect of that established geometry might also admit a physically meaningful description involving spatial compression and gradients in that condition.

For that possibility to advance scientifically, much more would be required.

A proposed compression quantity would need to be precisely defined. It would need to arise naturally from accepted geometric structures rather than being introduced arbitrarily. It would need to behave correctly in the Newtonian limit, remain consistent with General Relativity, and survive comparison with gravitational observations.

It may ultimately require a tensorial rather than scalar description.

It may reveal useful physical insight.

Or the attempt to formalise it may demonstrate that the interpretation cannot be sustained.

All three outcomes would be scientifically meaningful.

That is why this page should be regarded not as the mathematics *of* SpacePressure, but as the beginning of the mathematical question that SpacePressure would need to answer.

Where Would You Like to Go Next?

Continue the Technical and Research Journey

The next chapter widens the investigation to gravitational waves, black holes, cosmology, dark matter, dark energy, quantum gravity and other questions that may bear upon the SpacePressure Interpretation.

Continue to Further Exploring SpacePressure

Return to the Main Journey

Return to Chapter 3 and choose another pathway through the website.

Return to Starting the Formalising Process

Or See Where the Idea Ultimately Leads

If you would rather move from the technical question to the conceptual destination, continue directly to the deliberately conditional final chapter:

If SpacePressure Were Validated