Pressure–Curvature Dynamics, Surface Force, and Pressure Waves in Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law of Gravity)

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Abstract
This paper presents a unified formulation of gravitational interaction within Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law), consolidating the roles of mass density, gravitational pressure, field force, surface force, spacetime curvature, motion, and pressure–curvature waves. Gravity is interpreted as a pressure-driven phenomenon in which mass density generates gravitational pressure, pressure gradients produce field forces, curvature arises through the stress–energy tensor, and motion follows as a geometric response. Time-dependent curvature and pressure variations propagate as pressure waves. Particular attention is given to the distinction between field force and surface force, the interaction of pressure waves with nearby bodies, and the correct interpretation of wave propagation. The framework preserves all experimentally verified predictions of General Relativity while providing enhanced physical intuition and causal clarity.

1. Introduction
Newtonian gravity successfully describes orbital motion through forces, while General Relativity explains gravity as spacetime curvature. However, both frameworks leave open the question of the physical mechanism linking mass–energy to curvature.
Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law of Gravity) addresses this by identifying gravitational pressure as the physical mediator between mass density and spacetime geometry. This paper consolidates the foundational causal chain of PPC gravity and applies it to orbital systems, extended bodies, and pressure–curvature waves.

2. Mass Density and Gravitational Pressure

In PPC gravity, the fundamental material source is **mass density** ρ.
Through mass–energy equivalence, mass density corresponds to energy density:

$$E_d = \rho c^2$$

Energy density generates **gravitational pressure**, which represents the physical intensity with which matter acts on spacetime.

Heavier mass bodies generate higher gravitational pressure, while lighter bodies generate proportionally lower pressure. This hierarchy directly determines the strength of spacetime curvature.

3. Field Force of Pressure

Spatial variations in gravitational pressure produce a **pressure-gradient field force**:

$$\mathbf{F}_{\text{field}} = -\nabla P_g$$

This force:

- acts through space,
- governs acceleration and free fall,
- determines orbital motion.

The field force is **fundamental** in PPC gravity and corresponds to geodesic motion in curved spacetime.

4. Curvature via the Stress–Energy Tensor

Gravitational pressure and energy density enter spacetime geometry through the **stress–energy tensor**, producing spacetime curvature consistent with General Relativity.

Thus, in PPC gravity:

- **pressure is the physical cause**,
- **curvature is the geometric effect**.

5. Spacetime Curvature and Motion

Spacetime curvature defines the geometric structure in which bodies move.
Motion under gravity is understood as **geodesic motion**, arising naturally from pressure-induced curvature rather than from a mysterious attraction.

This interpretation preserves all classical and relativistic predictions of gravitational motion.

6. Surface Force: Definition and Role

When gravitational pressure acts on an **extended body**, it produces a **surface force**:

$$F_p = P_g A$$

where A is the effective surface area.

Surface force is:

- **not fundamental**,
- **derived from the pressure field**,
- applicable only to bodies with finite size.

Physical roles of surface force:

- binding of planets, moons, and stars,
- tidal effects and deformation,
- internal stress and compression,
- coupling between matter and pressure waves.

Surface force does **not** govern orbital motion; that role belongs to the field force.

7. Pressure–Curvature Waves

Pressure–curvature waves arise from **time-dependent variations in gravitational pressure and spacetime curvature**, produced by accelerated or non-uniform motion of mass–energy.

Key properties:

- They propagate at the **universal speed** c.
- Their **speed is independent of source mass**.
- Their **amplitude and energy depend on source mass and dynamics**.

Static curvature does not generate pressure waves; dynamical curvature does.

8. Interaction of Pressure Waves with Nearby Bodies

Pressure–curvature waves emitted by massive bodies can interact with nearby bodies.

Correct interpretation:

- The interaction occurs via **surface force**, not field force.
- Effects are **transient and dynamical**, not steady.
- Small bodies are affected more strongly due to lower inertia.

Effects include:

- oscillatory perturbations,
- slight trajectory modulation,
- induced stress and deformation.

Pressure waves **do not control orbital motion** and **do not alter wave propagation speed**.

9. Influence on Smaller Bodies and Secondary Emission

When pressure waves from a massive body act on a nearby smaller body:

- the smaller body's motion and pressure distribution can change,
- this can **modulate the amplitude, phase, and emission pattern** of pressure waves produced by the smaller body.

However:

$$\text{Wave speed remains } c \quad \text{for all bodies}$$

Interactions modify **wave characteristics**, not **wave speed**.

10. Hierarchy of Pressure, Curvature, and Waves

- Heavy mass bodies → high pressure → strong curvature → strong wave amplitude
- Medium mass bodies → moderate pressure and curvature
- Small bodies → weak pressure and curvature

But:

All pressure waves propagate at the same universal speed

11. Unified PPC Causal Chain

The complete PPC causal structure is:

$$\boxed{\text{Mass Density} \rightarrow \text{Pressure} \rightarrow \text{Field Force} \rightarrow \text{Curvature via Stress–Energy Tensor} \rightarrow \text{Spacetime Curvature} \rightarrow \text{Motion} \rightarrow \text{Pressure Waves}}$$

With derived physical response:

$$\text{Pressure Waves} \rightarrow \text{Surface Force} \rightarrow \text{Perturbation, Stress, Deformation}$$

12. Conclusion

This paper consolidates the Pressure–Curvature Law of Gravity as a physically intuitive and causally consistent framework for understanding gravity. By distinguishing clearly between field force and surface force, and between static curvature and dynamic pressure waves, PPC gravity provides clarity without altering experimentally verified predictions of General Relativity. Pressure waves are shown to act through surface force, affecting nearby bodies dynamically while propagating universally at the speed of light.

Key Statement

> *In PPC gravity, mass density generates pressure, pressure gradients govern motion, curvature shapes spacetime, and time-dependent curvature propagates as pressure waves that interact with matter through surface force.*