Forces of Pressure–Curvature Waves and the Binding of a Single Universe in Pawan Upadhyay's Pressure–Curvature Law of Gravity

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Abstract

Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law) proposes that gravitational phenomena arise from pressure generated by mass–energy, with spacetime curvature emerging as its geometric response. In this paper, gravity is analyzed explicitly in terms of forces transmitted by pressure–curvature waves. It is shown that large astronomical bodies generate pressure–curvature waves whose associated pressure gradients exert binding forces on smaller bodies within a single universe. The gravitational field force is formally expressed as $F = -\nabla P_g$, where the negative sign indicates motion toward decreasing pressure potential and increasing gravitational influence. The role of this force in binding planetary systems, maintaining cosmic structure, and defining the boundary of a single universe is discussed. The weakening of pressure–curvature wave forces at cosmic scales is shown to naturally lead to flat curvature, loss of binding, and the emergence of separate universes.

1. Introduction

Gravitational binding is fundamental to the structure of the universe, governing planetary systems, galaxies, and large-scale cosmic organization. Traditional formulations describe gravity either as a force acting at a distance or as motion along curved spacetime geometry. While mathematically successful, these approaches do not explicitly identify a physical carrier responsible for binding.

Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law) introduces pressure as the physical origin of curvature. This paper develops the force-based aspect of the PPC Law by explaining how pressure–curvature waves generate forces that bind matter within a single universe and how the weakening of these forces leads to cosmic separation.

2. Fundamental Principle of the PPC Law

The PPC Law is expressed as:

$$P_g = \omega E_d$$

where

- P_g is gravitational pressure,
- E_d is energy density,
- ω is the equation-of-state parameter.

The core causal chain is:

$$\text{Mass–Energy} \rightarrow \text{Pressure} \rightarrow \text{Curvature} \rightarrow \text{Motion}$$

In this framework, curvature is a consequence of pressure, not an independent primary entity.

Pressure variations propagate through spacetime as curvature disturbances, referred to as pressure–curvature waves.

3. Pressure–Curvature Waves as Force Carriers

Pressure–curvature waves arise from spatial and temporal variations in gravitational pressure generated by mass–energy. These waves carry information about pressure gradients across space and act as the mechanism by which gravitational influence is transmitted.

Key properties:

- Generated by massive bodies such as stars, planets, and galaxies
- Extend far beyond the source
- Govern the motion of matter embedded within them

Thus, gravity in the PPC framework is not static but dynamically mediated by pressure–curvature waves.

4. Definition of Gravitational Force in PPC Gravity

In continuum physics, pressure gradients produce forces. In PPC gravity, the gravitational force experienced by matter arises from gradients in gravitational pressure:

$$\boxed{\mathbf{F} = -\nabla P_g}$$

This equation defines the **force of pressure–curvature waves**.

5. Physical Meaning of the Negative Sign

- The negative sign in the force equation is essential and has a clear physical meaning.
- The gradient ∇P_g points toward increasing gravitational pressure.

- Physical forces due to pressure act from regions of higher pressure potential toward lower pressure potential.
- The negative sign ensures that matter moves down the pressure gradient, toward the source of gravitational influence.

Thus:

The force always acts toward regions where gravitational pressure is dominant, ensuring attractive gravitational behavior.

6. Binding of Structures Within a Single Universe

Within a single universe:

- Large bodies generate strong gravitational pressure.
- Pressure–curvature waves propagate outward.
- Strong pressure gradients exist around massive objects.
- Smaller bodies experience forces due to these gradients.

As a result:

Small planets and moons remain bound not because of their own pressure, but because they exist within the pressure–curvature wave fields of larger bodies.

7. Example: Earth–Moon–Sun System

The Moon illustrates pressure–curvature force binding clearly:

- The Moon has very low intrinsic pressure and weak curvature.
- Alone, it cannot generate strong gravitational binding.
- It remains bound because it lies within the combined pressure–curvature wave fields of the Earth and the Sun.

The binding force acting on the Moon arises from:

$$\mathbf{F}_{\text{Moon}} = -\nabla P_g^{(\text{Earth+Sun})}$$

This demonstrates that **external pressure–curvature forces dominate local**

This demonstrates that external Pressure - Curvature forces dominate local binding.

8. Forces, Curvature, and the Boundary of a Single Universe

At increasingly large distances:

- Pressure–curvature wave amplitudes decrease.
- Pressure gradients diminish.
- The magnitude of $-\nabla P_g$ approaches zero.
- Curvature becomes nearly flat.

- When pressure–curvature forces become negligible:

Large-scale gravitational binding fails, defining the effective boundary of a single universe.

9. Weakening of Forces and Emergence of Separate Universes

In the PPC framework, the formation of separate universes occurs when:

- Gravitational pressure becomes extremely low.
- Pressure gradients vanish.
- Forces carried by pressure–curvature waves disappear.
- Causal interaction between regions ceases.

Each region then evolves independently as a separate pressure–curvature domain, i.e., a separate universe.

10. Surface Force in PPC Gravity :-

X. Surface Force in PPC Gravity:

$F_p = P_g A$

In **Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law)**, gravitational interaction arises not only through field forces generated by pressure gradients but also through **surface forces** acting on extended bodies immersed in a gravitational pressure field. This surface interaction is an essential complement to the field force $\mathbf{F} = -\nabla P_g$.

X.1 Definition of Surface Force

The **surface force** in PPC gravity is defined as:

$$\boxed{F_p = P_g \, A}$$

where

- P_g is the gravitational pressure at the location of the body,
- A is the effective surface area of the body exposed to the pressure field.

This force represents the **direct action of gravitational pressure on the surface of matter**, analogous to pressure forces in classical fluid mechanics.

X.2 Physical Meaning of Surface Force

While the field force $-\nabla P_g$ governs motion through pressure gradients, the surface force F_p represents how **gravitational pressure couples to the physical extent of an object**.

Key interpretations:

- A larger surface area experiences a larger total pressure force.
- Even when pressure gradients are small, a finite pressure acting over a large area can produce a significant force.
- Surface force explains why **low-curvature, low-mass bodies can remain gravitationally bound**.

Thus:

Surface force allows gravitational pressure to act directly on extended matter, not only through gradients but through contact with spacetime pressure itself.

X.3 Role of Surface Force in Binding Small Bodies

Small bodies such as moons, asteroids, and dust particles possess:

- Low intrinsic gravitational pressure,
- Weak self-generated curvature.

However, when such bodies exist within the strong pressure–curvature wave fields of larger bodies (stars or planets), they experience a **non-negligible surface force**:

$$F_p = P_g^{(\text{external})}\, A$$

This force contributes to:

- Orbital stability,
- Long-term binding,
- Resistance to dispersal.

X.4 Example: The Moon

The Moon illustrates the importance of surface force clearly:

- The Moon has very low intrinsic curvature.
- Its self-generated pressure is weak.
- It remains bound because it is immersed in the **Earth–Sun gravitational pressure field**.

The Moon experiences:

- A **field force** due to pressure gradients:

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

$$F_p = P_g^{(\text{Earth+Sun})} \, A_{\text{Moon}}$$

Together, these forces maintain stable binding within the single universe.

X.5 Complementarity of Field Force and Surface Force

In PPC gravity, gravitational interaction is fully described only when **both forces are considered**:

- **Field force $\mathbf{F} = -\nabla P_g$:**
  Governs motion, acceleration, and orbits through pressure gradients.
- **Surface force $F_p = P_g A$:**
  Governs coupling between gravitational pressure and extended matter.

Thus:

> **Gravitational binding in PPC gravity is the combined effect of pressure-gradient forces and pressure-surface forces transmitted by pressure–curvature waves.**

X.6 Role in Defining the Boundary of a Single Universe

At cosmic scales:

- Gravitational pressure P_g becomes extremely small.
- Pressure gradients vanish.
- Both $-\nabla P_g$ and $P_g A$ approach zero.

When **both field and surface forces disappear**:

- Large-scale binding fails,
- Curvature becomes flat,
- Spacetime regions become causally disconnected.

This marks the **boundary of a single universe** and enables the formation of separate

This marks the boundary of a single universe and enables the formation of separate universes.

X.7 Role of the Surface Force of Pressure–Curvature Waves in Binding Small Planets within a Single Universe

In Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law), gravitational binding is governed not only by pressure-gradient (field) forces but also by surface forces arising from gravitational pressure acting on extended bodies. This surface interaction plays a crucial role in binding small planets, moons, and minor bodies within a single universe.

The surface force associated with pressure–curvature waves is defined as:

$$F_p = P_g . A$$

where **P_g** is the ambient gravitational pressure generated by nearby massive bodies and **A** is the effective surface area of the smaller body exposed to this pressure field.

Small planets typically possess low intrinsic gravitational pressure and weak self-generated curvature. As a result, their own pressure–curvature waves are insufficient to produce strong binding. However, when such bodies exist within the strong pressure–curvature wave environment of larger bodies—such as stars or massive planets—they experience a significant surface force due to the external gravitational pressure acting across their surface.

This surface force contributes to binding in several key ways:

1. Environmental Binding:
The surface force allows small planets to remain bound primarily due to the external pressure field, rather than their own mass or curvature.

2. Stability of Orbits:
Even when pressure gradients are relatively weak, a finite gravitational pressure acting over a large surface area produces a stabilizing force that supports long-term orbital motion.

3. Binding of Low-Curvature Bodies:
Bodies with very low curvature—such as moons and small planets—remain gravitationally confined because the surface force couples them directly to the surrounding pressure–curvature wave field.

4. Collective Action with Field Force:
The surface force operates alongside the field force $F = -\nabla P_g$, together ensuring stable binding within a single universe.

A clear example is provided by the Moon, which has very low intrinsic curvature and pressure, yet remains bound because it is immersed in the combined gravitational pressure field of the Earth and the Sun. The Moon experiences a non-negligible surface force due to this external pressure, which contributes significantly to its stable orbital configuration.

Thus, within the PPC framework:

The surface force of pressure–curvature waves is essential for binding small planets and low-curvature bodies, ensuring that they remain gravitationally confined within a single universe despite their weak intrinsic gravitational properties.

This interpretation highlights that gravitational binding in PPC gravity depends not only on local properties of matter but also on the pressure–curvature environment in which matter is embedded.

11. Complementarity of Field Force and Surface Force

In **Pawan Upadhyay's Pressure–Curvature Law of Gravity**, gravitational interaction is fully described by the combined action of:

- **Field force:**

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

- **Surface force:**

$$F_p = P_g A$$

The field force governs acceleration and orbital motion through pressure gradients, while the surface force represents the direct coupling of gravitational pressure to extended matter. Together, these forces explain stable binding within a single universe.

12. Implications

This force-based interpretation implies:

- Gravity has a clear physical carrier (pressure–curvature waves)
- Binding and separation are governed by force strength
- No exotic dimensions or additional fields are required
- A natural transition exists from bound systems to cosmic separation

13. Limitations and Future Work

This work is conceptual. Future research should:

- Quantify pressure–curvature wave amplitudes
- Define thresholds for force-driven cosmic separation
- Compare PPC force predictions with observational data
- Explore experimental tests of pressure-based gravity

14. Conclusion

In Pawan Upadhyay's Pressure–Curvature Law of Gravity, gravity arises from pressure–curvature waves acting through two complementary forces: the field force $F = -\nabla P_g$ and the surface force $F_p = P_g.A$. Strong pressure–curvature wave forces bind matter within a single universe, while the weakening of both forces at cosmic scales leads to flat curvature, loss of binding, and the natural emergence of separate universes.

Integrated PPC Force Statement

> **In the PPC Law, gravity arises from pressure–curvature waves through two complementary forces: the field force $\mathbf{F} = -\nabla P_g$ and the surface force $F_p = P_g A$. Together, they bind matter within a universe, while their weakening at cosmic scales leads to flat curvature and universe separation.**

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