Cosmological Acceleration and Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law of Gravity)

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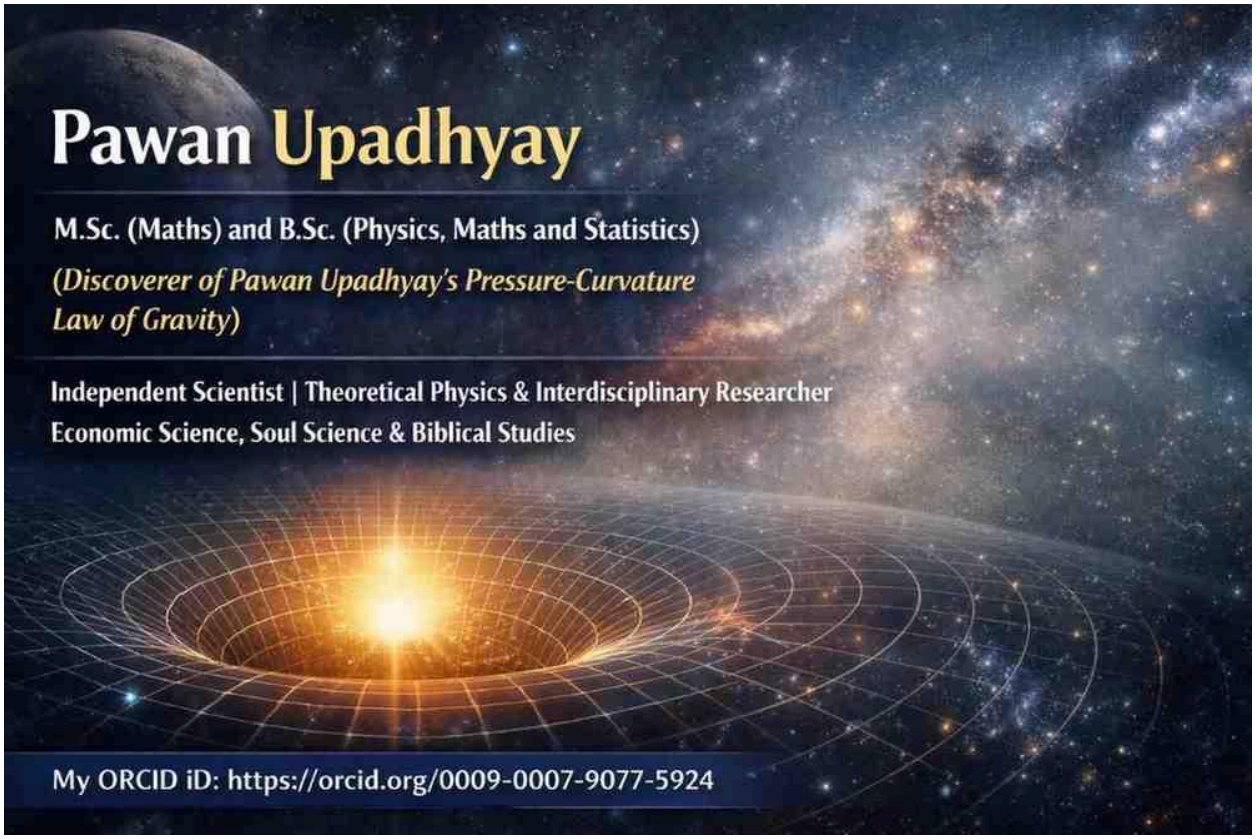

Abstract

Modern cosmological observations establish that the universe is undergoing accelerated expansion, a phenomenon that emerges naturally from Einstein's field equations when pressure is included alongside energy density. In this work, we show that the cosmological acceleration equation provides strong support for Pawan Upadhyay's Pressure–Curvature Law of Gravity

(PPC Law of Gravity). By identifying gravitational pressure as a central physical quantity and relating it to acceleration through the effective relation $P_g \sim \rho a L$, where ρ is mass density, a is acceleration, and L is a characteristic curvature length, we provide a physically transparent interpretation of cosmic acceleration fully consistent with General Relativity. The PPC framework does not modify Einstein's equations but clarifies their pressure-dominated implications.

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1. Introduction

The discovery of the accelerating expansion of the universe has fundamentally changed our understanding of gravity. Classical intuition based on mass alone is insufficient to explain this acceleration. Instead, General Relativity demonstrates that pressure plays a direct and often dominant role in governing spacetime dynamics. Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law of Gravity) builds on this insight by elevating gravitational pressure to a central interpretive role, offering a unified physical picture of acceleration, curvature, and force.

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2. Acceleration in Modern Cosmology

In relativistic cosmology, the acceleration of the cosmic scale factor $a(t)$ is governed by the equation derived from Einstein's field equations:

$$(\ddot{a} / a) \propto -(E_d + 3P_g)$$

Here, E_d denotes the energy density of the cosmic fluid and P_g denotes gravitational pressure. This equation leads to two key conclusions:

1. Pressure contributes three times more strongly than energy density to cosmic acceleration.
2. Negative gravitational pressure produces repulsive acceleration, driving the observed accelerated expansion.

These results demonstrate that pressure is not a secondary correction but a primary driver of acceleration in the universe.

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3. Gravitational Pressure as a Source of Acceleration

Within the PPC framework, gravitational pressure is interpreted as the scalar quantity responsible for mediating curvature and motion. Local gravitational dynamics are described by a field force density generated by pressure gradients:

$F = -\nabla P_g$

This field force density governs local acceleration and connects directly to the inertial response of matter. Acceleration therefore arises from spatial variations of gravitational pressure, rather than from mass alone.

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4. Effective Pressure–Acceleration Relation

To connect local field dynamics with macroscopic and cosmological behavior, the PPC framework introduces an effective geometric relation between gravitational pressure and acceleration:

$P_g \sim \rho a L$

In this relation:

- ρ is the mass density,
- a is the acceleration,
- L is a characteristic curvature length scale of spacetime.

This expression is not a fundamental field equation but an effective geometric relation obtained by integrating local pressure-gradient effects over the curvature scale L. It provides a direct physical link between pressure, acceleration, and spacetime geometry.

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5. Consistency with Cosmological Acceleration

Modern relativistic cosmology provides a direct link between acceleration, energy density, and pressure through the acceleration equation derived from Einstein's field equations:

$(\ddot{a} / a) \propto -(E_d + 3P_g)$

This equation establishes two empirically supported facts: (i) pressure contributes three times more strongly than energy density to acceleration, and (ii) sufficiently negative gravitational pressure produces repulsive (accelerated) expansion.

Within the PPC framework, gravitational pressure is related to acceleration and spacetime geometry through the effective relation:

$P_g \approx \rho a L$

where ρ is mass density, a is acceleration, and L is the characteristic curvature length. Substituting this relation into the cosmological context shows that accelerated expansion naturally corresponds to regimes in which gravitational pressure dominates the dynamics through curvature scale L.

Consequently, the cosmological acceleration equation does not introduce a new principle beyond General Relativity; rather, it provides strong observational support for the Pressure–Curvature interpretation by explicitly demonstrating that pressure governs acceleration. In this sense, modern cosmological observations are fully consistent with—and strongly support—the validity and physical accuracy of Pawan Upadhyay's Pressure–Curvature Law of Gravity.

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6. Relation to Einstein's Equations

The PPC Law of Gravity preserves the exact structure of Einstein's field equations and the geodesic equation. Energy density and pressure already appear as sources of spacetime curvature in General Relativity. The PPC framework reformulates these same dynamics in a pressure–curvature language, making explicit the causal role of pressure in generating acceleration and curvature without introducing new forces or modifying the theory.

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7. Discussion

Modern cosmology reveals that acceleration is a fundamental feature of the universe driven primarily by pressure. The PPC Law of Gravity captures this insight in a simple and physically transparent way. By relating gravitational pressure to acceleration and curvature through $P_g \sim \rho a L$, the framework unifies local force-density descriptions with global cosmological behavior.

This interpretation naturally accommodates dark energy, negative pressure, and repulsive acceleration within the established structure of General Relativity.

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8. Conclusion

The cosmological acceleration equation provides strong support for Pawan Upadhyay's Pressure–Curvature Law of Gravity (PPC Law of Gravity). Pressure, rather than mass alone, governs acceleration in the universe. The effective relation $P_g \sim \rho a L$ offers a clear physical interpretation of this fact, linking gravitational pressure, acceleration, and spacetime curvature in

a manner fully consistent with Einstein's equations. The PPC framework thus provides a compelling interpretive foundation for understanding modern cosmological acceleration.

Acknowledgments

The author acknowledges the foundational role of General Relativity and modern cosmology in shaping the Pressure–Curvature interpretation of gravity.

Final Takeaway:

While cosmological acceleration is governed by energy density E_d and gravitational pressure P_g, the PPC Law of Gravity relates gravitational pressure to local acceleration and curvature through $P_g \approx \rho a L$, thereby providing a physical bridge between local dynamics and global cosmological behavior.

One Line Summary:

The cosmological acceleration equation strongly supports the correctness and physical accuracy of Pawan Upadhyay's Pressure–Curvature Law of Gravity.