Planck Length and Planck Time the Fundamental Unit of Spacetime

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Abstract

The physical universe can be described in terms of motion, matter, and space. Time emerges not as a fundamental property, but from the comparison or interaction of two or more things in motion. This framework models the universe as divided into discrete units (Planck Length), with transitions between units occurring at a fixed delay (Planck Time). In a vacuum, light steps cleanly from one unit to the next, limited only by the delay, which results in the observed speed of light in Special Relativity. When mass is present, another delay emerges — mass — which introduces indirect paths and inefficiencies. This buildup of delay explains time dilation and the "falling" effect described in General Relativity. Within this model, Newton's gravitational constant (Big G) emerges as the ratio at which mass begins to significantly alter motion. By grounding spacetime in discrete, emergent units, this approach offers a framework that may be useful across other areas of physics.

Introduction

Spacetime is traditionally described through the lens of geometric curvature, mathematical formalism, and universal constants treated as fundamental. This paper proposes that such constructs are useful abstractions, but not the foundational reality. Instead, it argues that space and time emerge from the comparison and interaction of two or more things in motion. Within this view, mathematics is a descriptive language, and physical constants are not primitives, but ratios that arise from the interplay of matter, motion, and space.

Root of Physics

The mathematical approach presented here may initially resemble circular derivation, but the intent is to demonstrate emergent derivation — that complexity in the universe arises from simple foundational rules. This is grounded in the philosophical idea that perfection is not achieved when there is nothing left to add, but when there is nothing left to remove. From this perspective, all physical phenomena can be reduced to three fundamental entities: matter, motion, and space.

This framework stems from the argument that time is not a fundamental quantity, but an emergent one — a result of comparing two or more things in motion. This inherently relative nature of time will be explored through mathematical reasoning, with the aim of revealing the underlying structure of spacetime, gravity, and the origin of the gravitational constant G. The core motivation is to identify the true physical primitives.

Many, if not all, physical constants can be understood as ratios between matter, motion, and space. A prime example is Planck's constant, which — in this view — emerges from the relationship between a photon's momentum and its wavelength. The product of these two quantities always equals Planck's constant, suggesting it is not fundamental, but rather a ratio that reflects the underlying structure of reality.

This leads to a broader principle: most logical and mathematical structures are emergent — determined by the physical universe, rather than dictating it. For example, an object is not a "ball" because we label it as such, but because of the properties it exhibits in physical space. Likewise, Einstein's mass-energy equivalence does not cause diminishing returns at high velocities and mass, but rather describes the phenomenon that arises from deeper rules.

The Music of Motion: A More Accurate Analogy for Spacetime

To understand the structure of the universe, imagine it not as a geometric arena, but as a musical composition — one playing out across a grid of discrete units. Each unit of space is like the beat of a musical staff, ready for notes evenly spaced and ready to resonate.

In this model, Planck length is the beat the notes follow, and Planck time spaces of rest. The universe is not continuous, but quantized — structured like the notes of sound: finite, ordered, and rhythmically constrained.

Now imagine particles as wave patterns, like tones vibrating across the grid. A photon, the purest wave, has a wavelength that perfectly matches the rhythm — its oscillation aligns precisely with the spacing of the universe's fundamental beat. This is why light moves at the "speed limit" of reality:

$$Speed = \frac{Distance}{Time}$$

$$Speed\ of\ Light = \frac{Planck\ Length}{Planck\ Time}$$

— the most efficient motion allowed by the rhythm of spacetime.

Other particles — those with rest mass — vibrate out of sync. Their steps deviate slightly from the natural beat. Like musical notes that fall just off time, they produce inefficiencies. These off-beat steps require more cycles to traverse the same number of units. The result is slower motion, not because of resistance, but because of mismatched timing.

This is not a circular definition — it's emergent. The speed of light is a ratio, not a mystery — it emerges from the universe's smallest scale: the structure of space (Planck length) and intervals of pause (Planck time). Light just happens to be the one particle whose motion resonates perfectly with that rhythm.

This also leads to a prediction: because the speed of light is defined by the number of transitions (Planck units) over a given distance, then at very short distances — where fewer delays occur — light may appear faster than its average long-distance speed. This could offer insight into quantum behavior.

Extending the Analogy: Gravity as Distorted Harmony

So what, then, is gravity?

In this framework, gravity arises not from spacetime curvature, but from interference in the universal rhythm.

When mass enters the picture, it's like adding additional wave sources to the song. More tones are introduced — some harmonizing, others clashing. Every piece of matter becomes a note contributing to the composition, but too many notes in one place create dissonance. The beat remains fixed, but now the waveform becomes crowded. The rhythm is no longer pure.

Mass accumulates, the harmony breaks. The clean timing that photons follow in a vacuum — their perfect step — becomes disturbed. The buildup of mass introduces complexity: new waves, new oscillations, overlapping like dissonant notes.

This crowding causes interference. Non-light particles already deviate from the perfect rhythm — their wavelengths don't match the fundamental rhythm of spacetime. But now, even light is affected. The overlapping waves disrupt its perfect alignment. Because of this waves such as light retain the same amount of energy, but no longer move as efficiently, and in doing so, takes a longer path. The result is delay — not from intrinsic unalignment, but from loss of alignment with the foundational beat of the universe.

This is the second form of delay. The first is intrinsic — the rest of Planck time. The second is emergent — caused by the crowding and interference of other waves. Together, they give rise to gravitational time dilation. And what General Relativity calls "curved spacetime" is, in this view, the distortion of rhythm — the breakdown of clean motion across the Planck-scale musical grid.

From an external perspective, it looks like time is passing more slowly — not because the beat has changed, but because each transition now contains internal distortion causing less efficient travel. This is the essence of gravitational time dilation.

Particles tend to move toward areas where the harmony is more disrupted — not because they're pulled, but because their energy is less effective in those regions. Their oscillations are stretched, warped, and delayed. They fall into dissonance — toward mass.

In this light, Newton's gravitational constant G becomes a threshold of disharmony: the point at which crowding begins to noticeably distort the rhythm. Where classical relativity describes spacetime as curving, this model interprets that same effect as destructive interference in the music of motion.

Conclusion

This framework explains Special Relativity not as a property of smooth, continuous space, but as the ratio of rhythmic rests — Planck time intervals — across a measured distance. At short distances, there are fewer rests between beats, so movement appears nearly instantaneous. But as distance increases, these rests accumulate, creating diminishing returns that stabilize at the observed speed of light.

General Relativity emerges in a similar way. But here, the disruption doesn't come from distance — it comes from crowding. Mass introduces interference, distorting the timing and clarity of the fundamental rhythm. Even light — the particle with perfect alignment — begins to stagger as waves overlap. Harmony gives way to dissonance.

Without those rests — those intervals — you couldn't compare motion. Everything would blur into a single, unbroken stream. Rhythm requires contrast. Rest gives motion meaning.

And that's the deeper insight: Space is the staff — the structure that holds both moments for action (beats) and inaction (rests). Motion and matter are the notes — oscillations shaped by energy, frequency, and alignment.

From this view, the constants of nature — including the speed of light, Planck's constant, and Newton's gravitational constant — are not arbitrary. They are ratios born from the architecture of motion, matter, and space.

This musical interpretation of spacetime breaks it into discrete units — beats, rests, and notes — making it not only philosophically elegant, but potentially useful in extending physics to other domains such as quantum gravity, unification theories, and information flow. Rather than curving space, gravity bends rhythm.

In this view, spacetime isn't curved — it's composed.

Assumed Primitives:[1]

$$Planck\ Length\ =\ Beat$$

$$Planck\ Time\ =\ Rest$$

$$Photon\ Wavelength\ =\ Proportional\ To\ Photon\ Momentum\ =\ Note$$

$$Photon\ Momentum\ =\ Proportional\ To\ Photon\ Wavelength\ =\ Note$$

Time Calculation:

$$Time\ =\ \left[Planck\ Time\ ,\ for\ count\ from\ 1\ to\ \frac{Distance}{Planck\ Length}\right]$$

$$Time\ =\ \frac{Distance}{Planck\ Length}\ \times\ Planck\ Time$$

Speed:

$$Speed\ =\ \frac{Distance}{Time}$$

$$Speed\ of\ Light\ =\ \frac{Distance}{\left(\frac{Distance}{Planck\ Length} \times Planck\ Time\right)}$$

$$Speed\ of\ Light\ =\ \frac{Planck\ Length}{Planck\ Time}$$

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[1] Values that correspond directly to matter, motion, and space.

Photon Frequency:

$$Photon\ Frequency\ =\ \frac{Speed\ of\ Light}{Photon\ Wavelength}$$

$$Photon\ Frequency\ =\ \frac{\frac{Planck\ Length}{Planck\ Time}}{Photon\ Wavelength}$$

Photon Energy:

$$Photon\ Energy\ =\ Photon\ Momentum\ \times\ Speed\ of\ Light$$

$$Photon\ Energy\ =\ Photon\ Momentum\ \times\ \left(\frac{Planck\ Length}{Planck\ Time}\right)$$

Planck's Constant: [2]

$$Planck's\ Constant\ =\ \frac{Photon\ Energy}{Photon\ Frequency}$$

$$Planck's\ Constant\ =\ Photon\ Momentum\ \times\ Photon\ Wavelength$$

Angular Momentum:

$$\hbar\ =\frac{Planck's\ Constant}{2\pi}$$

$$\hbar\ =\ \frac{(Photon\ Momentum \times Photon\ Wavelength)}{2\pi}$$

[2] Momentum and wavelength must be real world values to have the correct ratio.

Gravitational Constant (G):

$$G = \left(\frac{\mathit{Planck\ Length}^5}{\mathit{Planck\ Time}^3}\right) \div \hbar$$

$$G = \left(\frac{\mathit{Planck\ Length}^5}{\mathit{Planck\ Time}^3}\right) \div \left(\frac{\mathit{Planck's\ Constant}}{2\pi}\right)$$

$$G = \frac{\left(\mathit{Planck\ Length}^5 \times 2\pi\right)}{\left(\mathit{Planck\ Time}^3 \times \mathit{Planck's\ Constant}\right)}$$

$$G = \frac{\left(\mathit{Planck\ Length}^5 \times 2\pi\right)}{\left(\mathit{Planck\ Time}^3 \times \mathit{Photon\ Momentum} \times \mathit{Photon\ Wavelength}\right)}$$

Gravitational Force :

$$\mathit{Gravitational\ Force} = \frac{G \times (\mathit{Mass\ A} \times \mathit{Mass\ B})}{\mathit{Distance\ Between\ Centers}^2}$$