Graviton Pressure Theory

The Unified Framework

Individual Submission

This document is part of a multi-part scientific framework

Part 24 of 30

Units, Constants and Conversions

The Numbers of the Medium

This submission is part of the broader Graviton Pressure Theory (GPT) project, a redefinition of gravitational interaction rooted in causal field dynamics and physical force transmission. Each document is designed to stand on its own; its full context emerges as part of the larger framework. For the complete series, see https://peopleoftheworld.net/graviton-pressure-theory/.

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About This Paper

Part 23 set out GPT's equations.[1] This paper gathers its numbers: the units it uses, the constants of the medium with how each is known, the conversions between GPT's quantities and the quantities instruments read, and a table of worked values from a GPS satellite to the horizon of a black hole, each checked against a measurement. It also gives GPT's derived quantities, coherence resistance, the coupling ratio and the graviton torque, in terms of what is measured.

This is the second edition; it joins two parts of the first, and the list at the end says what changed and why. The deep field, matter and medium under extreme compression, receives a short section here. Claims are marked by their status, as the key shows.

How to read the marks. Claims about Graviton Pressure Theory are marked by how far they are established.

Established	No mark. Accepted, measured physics.
Argued	Solid blue underline. A conclusion this framework argues in detail, which readers can check.
Hypothesis	Dashed orange underline. A proposal of GPT, not yet tested.
Open ○	Dotted grey underline and ○. A question not yet answered; work still owed.

A whole passage with one status carries a bar of the same style in the left margin. The marks are drawn in distinct line styles, so they read in black and white.

24.1 One System of Units

The graviton pressure unit, *gp*, is momentum delivered per unit area per unit time. It is the pascal, and this paper uses SI units throughout. GPT does not need new units. It needs new readings of the quantities that instruments already measure: a pressure in pascals is the medium's pressure; a frequency in hertz is a structure's rhythm; a speed of c is the speed of the medium's waves.

The SI itself has been rebuilt on rhythm and on the medium's wave speed. Since 2019 every SI unit has been defined by fixing the values of seven constants:[2]

- **the second** is 9,192,631,770 periods of the radiation from a transition in the caesium atom: a count of a structure's rhythm, which is what Part 18 says time is;[3]
- **the metre** is the distance light travels in 1/299,792,458 of a second: a length defined by the speed of the medium's waves;
- **the kilogram** is defined by fixing Planck's constant h, so that a mass is measured through the frequency $f = mc^2/h$. A kilogram corresponds to 1.36×10^{50} hertz.

In GPT this is not a convenience. Mass is the rate at which a pattern turns over the medium (Part 17), and mc^2/h is that rate. It has been measured directly: in 2013 Müller's group used atom interferometry to make a clock that ticks at a fraction of a caesium atom's own mass frequency, a clock "directly linking time to a particle's mass", though the interpretation of that experiment has been debated.[4][5]

[1] Rashada, 2026j.
[2] Bureau International des Poids et Mesures, 2019.
[3] Rashada, 2026f.
[4] Lan et al., 2013.
[5] Rashada, 2026e.

Constant	Value	How known	GPT reading
Speed of light, c	299,792,458 m/s	fixed by definition, after measurement	speed of the medium's transverse waves, light and gravitational waves alike (Part 15)
ε_0, μ_0	8.854×10^{-12} F/m; 1.257×10^{-6} H/m	measured	the medium's own constants; $c = 1/\sqrt{\varepsilon_0 \mu_0}$ (Part 22)
Impedance of free space, $Z_0 = \sqrt{\mu_0/\varepsilon_0}$	376.73 Ω	measured	physics already names an impedance of empty space: the medium's
Planck's constant, h	6.626×10^{-34} J s	fixed by definition, after measurement	sets each structure's rhythm, $f = E/h$ (Part 18)
Boltzmann's constant, k	1.381×10^{-23} J/K	fixed by definition	the energy of the knocks per degree (Part 20)
Elementary charge, e	1.602×10^{-19} C	fixed by definition	the hand of a knot (Part 19); why it comes in one size is owed
Gravitational constant, G	6.674×10^{-11} $m^3/kg\,s^2$	measured, to about 2 parts in 10^5, with unexplained scatter	sets the inflow of a mass, $v^2 = 2GM/r$; how intake relates to mass is owed
Free-space pressure, P_0	about 4.5×10^{-10} Pa	inferred: clock law and heat budget (Part 23)	the medium's active pressure far from matter
Medium density, ρ_g	about 1.0×10^{-26} kg/m^3	derived, $\rho_g = 2P_0/c^2$	density of the active, pressure-bearing part
Boundary acceleration, a_0	about 1.2×10^{-10} m/s^2	measured, from galaxies	where each mass's inflow relaxes (Part 23)

Table 24.1: The constants GPT uses. The first seven are measured or fixed by the SI. Of the last three, P_0 and ρ_g are GPT's inferences, and a_0 is measured, with GPT's reading of it.

24.2 The Constants of the Medium

Table 24.1 lists the constants GPT uses, with how each is known and what GPT reads it as.

Three of these deserve comment.

- Empty space has a measured impedance, 376.73 ohms: the ratio of the electric to the magnetic part of a light wave travelling through it. An impedance is a property of a medium; for a string it is its tension and density, for air its density and the speed of sound. In GPT, Z_0 is the medium's, measured in electrical units. The graviton impedance has a mechanical form from Part 23: $\rho_g c \approx 3.0 \times 10^{-18}$ kg/m^2 s.
- P_0 is GPT's least certain constant. Only the inflow speed enters orbits, clocks and light; the medium's pressure and density cancel. P_0 is fixed by requiring the pressure and clock laws to agree, $P_0 = \frac{1}{2}\rho_g c^2$, and by the heat budget: at this value the Earth would absorb a ten-thousandth of its measured heat flow and the Sun a hundred-billionth of its output, if they kept the energy of what flows in (Part 23).
- G is the least precisely known constant of physics: measurements by different methods

Place	Inflow v	$\Delta P/P_0$	Clock slowing	g (m/s^2)	Measured check
GPS orbit, 26,560 km	5.48 km/s	3.3×10^{-10}	1.7×10^{-10}	0.57	GPS clocks gain 45.7 μs a day over the ground from height
Earth's surface	11.2 km/s	1.4×10^{-9}	7.0×10^{-10}	9.8	22.5 m tower: 2.5×10^{-15} (Pound and Rebka)
Sun's surface	618 km/s	4.2×10^{-6}	2.1×10^{-6}	274	redshift 636 m/s (633 as received at the Earth); measured 638 ± 6 m/s
White dwarf Sirius B	6,930 km/s	5.3×10^{-4}	2.7×10^{-4}	4.3×10^{6}	redshift 80.0 km/s; measured 80.65 ± 0.77 km/s
Neutron star, 1.4 solar masses, 12 km	$0.59c$	0.35	0.19	1.3×10^{12}	radii of 12–13 km measured (NICER)
Black hole horizon, $r = 2GM/c^2$	c	1	clocks stop, seen from far away	—	shadow sizes measured (EHT)

Table 24.2: Worked values. Inflow, pressure fall and clock slowing from the conversions of Section 24.3; the checks are measurements.

disagree by more than their stated errors.[6] The scatter is unexplained.

24.3 Conversions

HYPOTHESIS

These are the conversions between GPT's quantities and the quantities instruments read, from Part 23. For one mass M at distance r:

- the inflow speed of the medium: $v = \sqrt{2GM/r}$;
- the fall in the medium's active pressure: $\Delta P/P_0 = v^2/c^2 = 2GM/c^2 r$;
- the common slowing of clocks: $d\tau/dt = \sqrt{P/P_0} = \sqrt{1 - v^2/c^2}$;
- the medium's acceleration, shared by every body: $g = GM/r^2$;
- the relaxation boundary: $r_{a_0} = \sqrt{GM/a_0}$.

The pressure and the clock rate are one quantity read two ways. A clock that runs slow by a part in a billion sits where the medium's active pressure is lower by two parts in a billion.

24.4 Worked Numbers

Table 24.2 applies the conversions from a GPS satellite to the horizon of a black hole. Every row is checked by a measurement (Figure 24.1).

The checks:

[6] Rothleitner and Schlamminger, 2017.

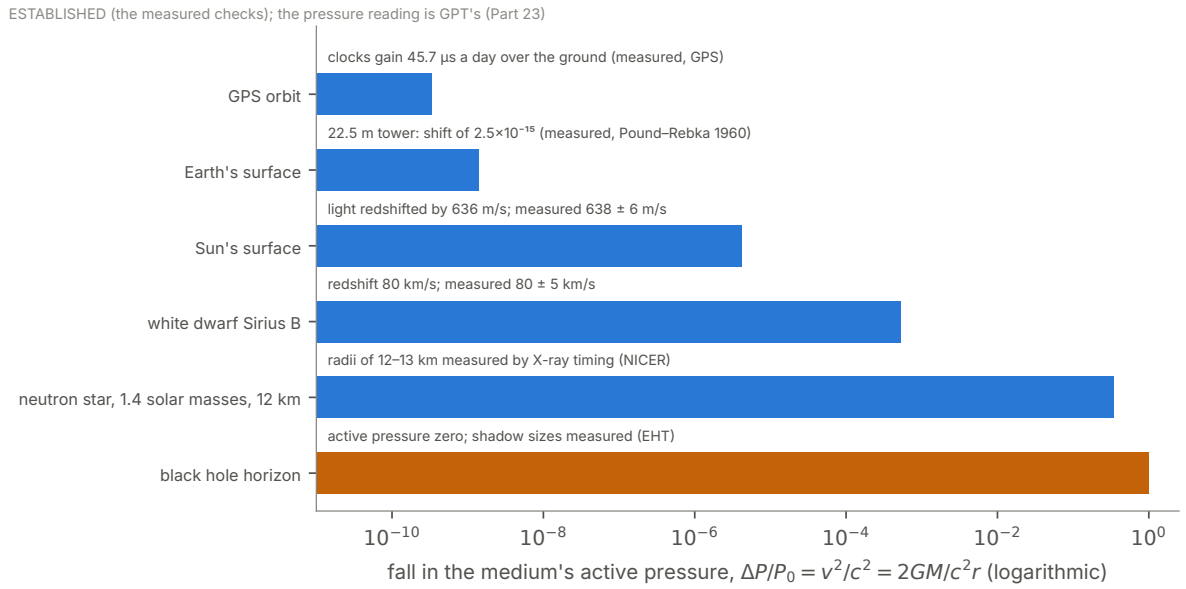

Figure 24.1: The fall in the medium's active pressure from a GPS orbit to a black hole's horizon, across ten orders of magnitude, with the measurement that checks each step. At the horizon the active pressure is zero.

- **GPS.** The satellites' clocks run fast relative to the ground by 45.7 microseconds a day because of their height, and slow by 7.2 because of their speed; the system corrects for both, and it would drift by kilometres a day without them.
- **Pound and Rebka**, 1960: light sent up a 22.5-metre tower at Harvard arrived shifted by 2.5×10^{-15}, within 10%, later 1%.[7]
- **The Sun**: light from its surface reaches us shifted by 638 ± 6 metres a second, against 633 expected for light received at the Earth's distance (636 from the surface to far away).[8]
- **Sirius B**: the Hubble Space Telescope measured its light shifted by 80.65 ± 0.77 kilometres a second, against 80.0 expected from its mass and radius.[9]
- **Neutron stars**: X-ray timing from the International Space Station has measured their radii, 12 to 13 kilometres for about 1.4 solar masses.[10]
- **Horizons**: the Event Horizon Telescope imaged the shadows of the black holes in M87 and at the centre of the Milky Way, at the sizes expected from their masses.[11][12]

The relaxation boundary, from the same conversions: about 7,000 astronomical units for the Sun, and 8 to 11 kiloparsecs for the Milky Way, where its rotation curve flattens (Part 23).

24.5 Rhythms

Every structure has a rhythm set by its energy, $f = E/h$ (Part 18).

[7] Pound and Rebka, 1960.
[8] González Hernández et al., 2020.
[9] Joyce et al., 2018.
[10] Riley et al., 2019.
[11] Event Horizon Telescope Collaboration, 2019.
[12] Event Horizon Telescope Collaboration, 2022.

- the electron, 1.24×10^{20} hertz; the proton, 2.27×10^{23};
- the caesium transition that defines the second, 9,192,631,770 hertz;
- the hydrogen line, the most common radio signal in the universe, 1,420 megahertz;
- the strontium optical clock, 429 terahertz, stable to about a part in 10^{18}.

This rhythm is the structure's temporal resolution rate, in s^{-1}.

24.6 Stiffness: The Second Pressure

Coherence resistance, C_{res}, is how well a structure resists compression. The measured quantity is the elastic modulus: the bulk modulus, the pressure needed to compress a material by a given fraction. Diamond's is 443 gigapascals, iron's 170, lead's 46, water's 2.2. Its scale is set by the energy of the bonds: iron's cohesive energy is 5.8×10^{10} joules per cubic metre. In GPT this is the second pressure, the energy of the medium organised into matter's bonds, distinct from the medium's free-space pressure (Part 20).[13] C_{res} is these measured moduli.

24.7 Spin and Orbit

A graviton torque acts on a spinning body,

$$T = -\gamma\,(\Omega - \Omega_{\text{corr}}), \tag{1}$$

driving its spin Ω toward a preferred rate Ω_{corr}. This is the form of the tidal torque, with Ω_{corr} the orbital rate and γ set by the friction inside the body as it is flexed by the tide. It drives a spin toward lock, and the Moon, which always shows the Earth the same face, has reached it. In GPT the tide is the difference in the medium's inflow across the body, and the torque is delivered through the medium (Part 13).[14]

The coupling ratio of spin to orbital angular momentum, $\kappa = I\omega/mvr$, does not decide locking: it is about 2×10^{-7} for the Earth and 8×10^{-6} for the locked Moon. What decides whether a body locks is the time it takes, which grows as the sixth power of its distance from what raises the tide and depends on its rigidity and internal friction.[15] The measured pattern follows: the large moons close to their planets are locked, Pluto and Charon are locked to each other, and Mercury, close to the Sun, is held at three turns for every two orbits.

24.8 The Strong Field

The deep field needs no nonlinear term for the motion of the medium: Part 23's inflow, $v^2 = 2GM/r$, holds at every strength, and in that form it reproduces the exact field of a non-rotating black hole (the Painlevé–Gullstrand form). What the strong field adds is two things.

HYPOTHESIS

The horizon is where the medium's active pressure reaches zero. The pressure falls as

[13] Rashada, 2026h.
[14] Rashada, 2026a.
[15] Gladman et al., 1996.

$P = P_0 - \frac{1}{2}\rho_g v^2$, and $P_0 = \frac{1}{2}\rho_g c^2$, so where the inflow reaches the speed of light, at $r = 2GM/c^2$, the active pressure is exactly zero. Inside, the medium flows inward faster than its own waves can travel, and nothing carried by those waves can get out. For ten solar masses the horizon is about 30 kilometres in radius; for the black hole in M87, about 130 astronomical units.

What the medium is inside the horizon is owed ○: there the pressure formula goes below zero, and a self-repelling medium cannot have negative pressure. Something in the account changes there.

HYPOTHESIS

Dense stars are held up by exclusion, to a limit. Patterns of the same circulation cannot share a place (Part 19). In a white dwarf the electrons, packed as closely as exclusion allows, hold the star up; in a neutron star, the neutrons do. Each has a limit, beyond which the inflow's compression wins.

The limits are measured. No white dwarf has been found above about 1.4 solar masses, the limit Chandrasekhar calculated in 1931;[16] the heaviest neutron star measured is 2.35 ± 0.17 solar masses.[17] A fuller account of matter and medium under extreme compression is under consideration as its own paper.

24.9 What Remains to Be Derived

- G from the medium: the relation between a mass and its intake. ○
- An independent measurement of P_0, and the factor $\frac{1}{2}$ in $P_0 = \frac{1}{2}\rho_g c^2$. ○
- The value of a_0, from the rate at which the medium re-phases its ejecta (Part 15). ○
- The size of the elementary charge, from the knot's hand. ○
- What the medium is inside a horizon. ○
- The limits of white dwarfs and neutron stars from exclusion, in GPT's terms. ○

Conclusion

GPT uses the SI throughout, and the SI itself is now defined by rhythm and by the speed of the medium's waves: the second is a count of a caesium atom's rhythm, the metre is set by c, and the kilogram is measured as a frequency. The medium's constants are partly measured, its electrical constants and its impedance of 376.73 ohms, and partly GPT's own: a free-space pressure of about 4.5×10^{-10} pascals and a density of about 10^{-26} kilograms per cubic metre. The conversions from GPT's pressure to the quantities instruments read take a single form, and they are checked from a GPS satellite, where the pressure falls by three parts in ten billion, to the horizon of a black hole, where it falls to zero. GPT's derived quantities are measured ones: stiffness, the tidal torque and the time it takes to lock, and the rhythm of each structure.

[16] Chandrasekhar, 1931.
[17] Romani et al., 2022.

Changes in the Second Edition

This list records what changed from the first edition and why. Changes to the argument alter what the paper claims or how it supports a claim; clarifications improve wording, sources or presentation and leave the argument as it was.

Changes to the argument

- The first edition's Part 24 is merged with the constants and conversions of its Part 25. The deep field receives a short section; a fuller treatment is under consideration.
- The graviton pressure unit gp is identified as the pascal; SI units are used throughout. New: the SI's 2019 definitions as rhythm and wave speed, and the kilogram as a frequency, with the Compton clock.
- The area-based orbital force $F = gp \cdot A = mv^2/r$ is withdrawn: bodies at the same radius orbit at the same speed whatever their shape or composition. Gravity acts on every particle (Part 14).
- The light-speed formula $v = c/(1 + \beta\, gp)$ is withdrawn: it has light slowed where the pressure is higher, but light is slowed near masses, where the medium's pressure is lower. Part 23's index replaces it.
- Shell stratification by Δgp is withdrawn as written: at any instant an orbit is possible at any radius; structure built over time is in Part 16.
- New: a table of constants with how each is known, including the measured impedance of free space; a table of worked values from a GPS orbit to a black hole's horizon, each with its measured check.
- Coherence resistance is replaced by the measured bulk modulus and the energy density of bonds. The graviton torque is kept as the tidal torque. The lock criterion $\kappa \approx 1$ is replaced by the time to lock. The temporal resolution rate is the rhythm E/h. The graviton impedance is identified with the medium's impedance.
- The resonance feedback coefficient R_{field}, the coherence density, the graviton coupling coefficient κ_g and the constants α and γ are withdrawn: none was defined by a measurement. The estimated value ranges are retired; P_0 is about 4.5×10^{-10} pascals (Part 23).
- The deep-field equation with its nonlinear term is withdrawn: the inflow holds at every strength. The resonance-lock wave $P_0 \cos(\ldots)e^{-\gamma t}$ is withdrawn: it makes the pressure negative half the time. New: the horizon as the surface where the active pressure reaches zero, and dense stars held by exclusion to measured limits.
- Removed, as too far from the core: the calibration instruments (resonance-matched instruments, stratified field mapping, orbital corridor diagnostics), the resolvable pressure of 10^{-8} pascals, the multiscale claims for biology and galactic corridor bifurcation, and the closing on propulsion and shielding.
- The free-space pressure estimate of 10^{-6} to 10^{-4} pascals is retired; $P_0 \approx 4.5 \times 10^{-10}$ pascals passes the heat budget (Part 23).

Clarifications

- The title changes from *GPT Unit System and Dimensional Foundations* (with the companion *Constants, Conversions and Deep Field Formalism*) to *Units, Constants and Conversions*, with

the subtitle *The Numbers of the Medium*.

- The cross-references to later parts are renumbered.
- One figure, two tables, status marks and this list are added.

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