# A Resolution of the Vacuum Catastrophe

Described as "the worst theoretical prediction in the history of physics." the vacuum catastrophe can best be described as the roughly 120 orders of magnitude difference between measured gravitational values of the vacuum energy density and a theoretical zero-point energy suggested by naïve application of quantum field theory. The nature of vacuum energy continues to be ambiguous. The interacting quantum field, its renormalization, and its interaction with gravity in Minkowski space (that is, in our real universe) is still being debated. Does the vacuum energy gravitate? Walther Nernst questioned the consequences of the huge vacuum energy on gravitation. How does one calculate the vacuum density? Is summing the quantum mechanical zero point energies a valid approach? Is it uniform, or does it reveal varying energy probability with varying local mass?

This paper proposes that increasing gravitational effects of a body or group of bodies augment the likelihood of quantum interactions occurring. The reverse of this is also true. The emptier space is, the less likely it becomes to have quantum interactions occurring.

**Introduction**

We know that the Planck Interaction is universal, and it is well known that the Planck particle/mass as a quantity exists within its own Schwarzschild radius where

$$\mathrm{R_{s_p}} = 2\mathrm{l_p} = 2\lambdabar_\mathrm{p}$$

**The Planck/Lorentz mass limit**

As a “particle” approaches the velocity “c”, it enters the relativistic Lorentz space, its relative time contracts or slows down (dilation), its curvature becomes much higher (smaller) as reflected in the Lorentz contraction, and its mass becomes greater, until reaching the Planck mass, (this, before reaching the speed of light “c”).

The physical limit of contractibility, the Planck length; the minimum of time $\boldsymbol{l_p}$, of mass, the Planck mass $\boldsymbol{m_p}$, and of force, the Planck force $\boldsymbol{F_p}$, are never breached. This limiting action is a function of the Lorentz limits.

As an example we consider a single test particle (in free fall), falling (under acceleration) through the event horizon, (into a black hole), and then being accelerated towards a Planck singularity, and on final approach towards obtaining the speed of light.

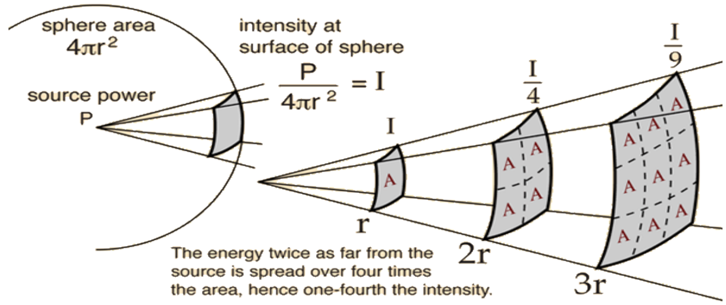
Where, $l_v = l_0\sqrt{1-\frac{v^2}{c^2}}$ $t_v = t_0\sqrt{1-\frac{v^2}{c^2}}$ $m_v = \frac{m_O}{\sqrt{1-\frac{v^2}{c^2}}}$,

In all of these cases, (whether length, time, or mass), achieving the velocity of light is impossible. These limits stipulate the formation of a Planck mass when approaching the speed of light (and in every case before attaining it). The particle (or conglomeration of individual particles…a body), begins to shrink as its energy increases. As this mass/energy increases, approaching the Planck scale, its de Broglie radius, and Schwarzschild radii become more equal. According to the equation below:

$$l_P^2 = \frac{R_{s_x}\lambda_x}{2}$$

At half the Planck mass the de Broglie radius is two times the Schwarzschild radius. At 0.707 Planck mass the two radii are equivalent, with a horizon force equal in intensity to the singularity perimeter force at $3.02585e^{43}$ N or ¼$^{th}$ of the Planck force (1), and the particle is still accelerating (still obeying the equation above). The force at these radii is equivalent to the black hole force mentioned above. At one Planck mass the particle is engulfed in its own black hole by a factor of two Planck lengths. And, (still accelerating) its mass/energy has self-de-coupled from its own space-time been engulfed as a "in a black hole" with a horizon force equal in intensity to the singularity perimeter force of $3.02585e^{43}$ N or ¼$^{th}$ of the Planck force, and a related virial total force of ½ of the Planck Force. Its time experience has slowed/dilated dramatically! Yet the acceleration is permitted still! But before achieving the velocity of light…before time approaching a full stop, the particle disappears into its own (self-generated) black hole! We have then a black hole traveling at nearly the speed of light, but at which no more movement would be possible since time must have dilated (or slowed) extremely. Let's hold that thought.

What does the rest of the universe share with the new black hole we just created (3)? Might one do this transformation in reverse? The Planck mass is well known to qualify as a black hole, as also does the Universe (3). We know that for light rays there is a source to distance intensity relationship demonstrated nicely in the graphic below.




http://hyperphysics.phy-astr.gsu.edu/hbase/acoustic/invsqs.html

Therefore, setting a "norm" in Planck units for any initial radius $r_i$ we have

$$r_x = \frac{r_i}{l_p}$$

$$I = \frac{P}{4\pi r_x^2}$$

Where the intensity at some relative normalized distance ($r_x$) reduces as the square of this "radius" from the strength of the source intensity,

For any particle$_{(x)}$ or light$_{(x)}$ this norm/ratio $r_x$ may be used for any Compton radius to relate electromagnetic "Columbic" force directly to the Zero point force,

$$F_{x_{Columbic}} = \frac{F_P}{4\pi r_x^2}$$

The gravitational force is also constant at the Schwarzschild radius of the particle in question, in a direct relation to the Planck length, Berkenstein's constant, and the Graviton mass/length, seen in (5) by using the formula below.

$$\sqrt{\frac{2G\hbar}{2c^3}} = \sqrt{\frac{M_G}{2}} = \sqrt{\frac{R'_{Sw}\lambda\!\!\bar{}\,'}{2}} = l_P$$

From this we can see in a semi-classical framework that the Planck Zero Point Gravitational Force constant $\frac{F_P}{2}$ (Planck force divided by two) is directly related to any and all particle(s)$_x$ in the universe, by their Columbic influence (force) at their de Broglie and Schwarzschild radii, and the universal constant alpha α as here shown.

$$\frac{\sqrt{F_{c_{de\ Broglie_x}} F_{c_{Schwarzschild_x}}}}{\alpha} = \frac{F_P}{2}$$

Where

$$F_p = \frac{\hbar}{l_p t_p} = \frac{E_p}{l_p} = \frac{c^4}{G}$$

There is a direct relation here to General Relativity, in Einstein's Field equations where

$$G_{uv} = 8\pi \frac{G}{c^4} T_{uv} = \frac{8\pi T_{uv}}{F_p}$$

Where $G_{uv}$ is the Einstein tensor and $T_{uv}$ is the energy momentum tensor.

So as shown above, any particle$_{(x)}$ or light$_{(x)}$ through the norm/ratio $r_x$ may be used for any Compton radius to relate not only electromagnetic "Columbic" force directly to the Planck Zero Point Force, but also to the Planck Zero Point Gravitational Force constant and General Relativity.

$$\frac{F_{x_{Columbic}}}{2} = \frac{F_P}{8\pi r_x^2}$$

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**The Singular Nature of Space**

The energy density of the vacuum involves two fundamental theories of physics then: quantum field theory and general relativity. General relativity determines the energy density of the vacuum by measuring the curvature of space-time i.e by gravity. Zero gravity implies no curvature, or Newtonian motion. The maximum continuous gravitational curvature possible is found at 2 Planck lengths $2l_p$. The Planck length itself is the minimum continuous quantum curvature possible.

The Planck mass, as mentioned above is well known to qualify as a black hole, but let it be remembered that the Universe itself qualifies as a black hole as well (3).

So then, how much does a black hole weigh? As shown (5), the universal (*black hole*) equilibrium maintains a total mass (per radius meter) of $6.733e^{26}\ kg/m$. Or, in terms of energy… $6.051e43\ J/m$.

All black holes weigh that same amount per meter. If this interchange between space and mass really is valid at Planck scales, then we expect results like the following for the Planck mass

$$\frac{M_p}{R_{s_p}} = constant = 6.733e^{26}\frac{kg}{m} = 6.051e^{43}\frac{J}{m}$$

The Schwarzschild radius of the Planck mass is equal to two Planck lengths. The effective mass, for the Planck length itself, would be ½ of the Planck mass

$$1.6162e^{-35} \times 6.733e^{26}\ kg = \frac{1}{2}m_P$$

Now since $E = Mc^2$ to get the Zero-point energy, then $\frac{M_P c^2}{2} = \frac{\mathrm{E}_P}{2}$, we use ½ the Planck Zero-point energy or

$$\frac{1.9561e^9 J}{2}$$

The Zero-point Vacuum "gravitationally equivalent" energy density (in meters cubed) would be ½ of the Planck mass, therefore.

$$\frac{M_P c^2}{2l_p^3} = \ 2.31678\mathrm{e}^{+113} J$$

The Equilibrium model Universal Vacuum/Zero-point energy would be

$$\frac{M_U c^2}{2} = 4.074e^{70} J$$

The Universal Vacuum energy density (in meters cubed) would be

$$\frac{M_U c^2}{R_U^3} = \ 1.335e^{-10} J$$

The ratio of these two values would be

$$\frac{2.31678e^{+113}}{1.335e^{-10}} = 1.7354e^{+123}J$$

And thus, we have the vacuum catastrophe.

But as you can see, we arrived at this “great discrepancy” from the same unit mass per length. When spreading the energy values out over the cubed distances, (the vacuum energy) the unit of measure is biased towards our own reference frame, i.e., the meter.

| | **Non-Cubed** | **Cubed** |
|---|---|---|
| Planck | $\frac{1.9561e^{9}J}{(2)l_p} = 6.050e^{+43} = \frac{F_p}{2}$ | $\frac{1.9561e^{9}J}{2l_p{}^{3}} = 2.31678e^{+113}J/m^3$ |
| Unit | $\frac{x}{1} = x$ | $\frac{x}{(1)^3} = x$ |
| Universe | $\frac{4.074e^{70}J}{6.733e^{26}} = 6.050e^{+43} = \frac{F_p}{2}$ | $\frac{4.074e^{70}J}{(6.733e^{26})^3} = 1.335e^{-10}J/m^3$ |

The discrepancy is $1.7354e^{+123}J$; the “stretching out of space” is the source of this great discrepancy, and nothing else.

The Ru value or ($6.733e^{26}$) is the Schwarzschild equilibrium radius generated by the total mass of the universe (3). A simple (though little accepted) way to derive this value is using “c” as the minimum theoretical escape velocity from a black hole

$$V_e = \sqrt{\frac{2GM}{R_s}}$$

$$c = \sqrt{\frac{2GM}{R_s}}$$

Then

$$\frac{M}{R_s} = constant = 6.7334e^{26}kg/m = \frac{c^2}{2G}$$

This value is universal. All black holes weigh that same amount per meter.

Remarkably, the Graviton’s probability radius (5) is one half (½) of this value.

$$\sigma_x \geq \frac{\hbar}{2\sigma_p} = \frac{R_u}{2} = 3.33667\text{e}^{26}\,\text{m}$$

As defined as well by the Gaussian deduction of the Gravitational force radius.

So then, for the "Universal Vacuum energy value, we have $1.335e^{-10}$ J per meter$^3$, this is an ***average*** minimum value for the whole universe. At 1.975e$^{-29}$kg/m$^3$, it shows the basic "tension" per meter$^3$ that must be overcome to begin to accumulate mass, slightly less than 1/10 of one muon mass per meter$^3$. We consider $5.7918e^{+112}J/m^3$ as the maximum value obtainable for the vacuum, because of the Lorentz limits.

Resuming with the "hold that thought", remember that our test particle (as it accelerates towards the speed of light) is also experiencing an internally driven acceleration. Its essential-internal mass is increasing, and its outlying "components" are beginning to perceive a greater and greater gravitational pull towards its center of gravity. With larger mass the Schwarzschild radius/singularity expands and its de Broglie radius contracts. At the Planck Interaction (1) inflection point, the body no longer participates "normally" with the outside world, but participates only quantically, thru the Heisenberg uncertainty principle. Its gravitational interactions are all determined quantically, as shown in (5).

In one sense at least, for conglomerated matter or particles, the transformation of typical in-falling mass/energy is "seamless". The Schwarzschild - de Broglie product ($R'_{Sw}\lambda\!\!\!^{-}{}'$) never changes. All masses respect the relation in accordance with Berkenstein's law.

$$R'_{Sw}\lambda\!\!\!^{-}{}' = 2l_P^2 = 2\lambda\!\!\!^{-}{}_P^2 = 2\frac{G\hbar}{c^3}$$

So that as the mass approaches the relativistic Planck mass (still in free-fall), it perceives only self-generated mass/energy increases.

Now then, a particle approaching the speed of light, but not in observable movement relative to let's say, a swirling galaxy outside, is all clogged up with a Lorentz affected time that does not really permit further collapse. But at every moment and location in time (and the universe), the entangled Planck bosonic graviton - Heisenberg super-positioning is already occurring (as shown above).

The Berkenstein expansion result for $\boldsymbol{R'_{Sw}}\lambda\!\!\!^{-}{}' = 2l_p^2 = 2\frac{G\hbar}{c^3}$ reflects the nature of the event horizon for the black hole in question, the universe is still moving and still "sees" it. The black hole becomes one more point around which the universe twirls. In fact all of the "outside" particles are already part of these interactions.

**The Heisenberg Principle inside/outside of Black Holes**

How do black holes attract things if the speed of gravity is equal to the speed of light? Shouldn't gravity stay inside as well? Yes it should, but it turns out that the Heisenberg Principle permits interaction between all black holes, and between all particles in the dispersed gravitational foci of the universe. As is shown above, all particles have a direct relationship with the graviton, and as such, all gravitational interactions are internally motivated, i.e. we only feel a "force" of gravity because we are stopped against something. Thus, Einstein's space-time concept continues valid.

This leads us to consider the nature of the ultimate black hole, the mother of all black holes, the universe.
Does this transformation still newly occur today; was it at one time quite frequent? Do "bits" of shall we say "info-mass" obtain light velocity and enter their own Lorentz field, their inertia becoming a measure of their quantized amounts of relative time dilation, quantized by the formula?

$$\frac{R_x \lambda_x}{2} = l_P^2$$

On a universal scale, an object's inertia is proportional to its local time dilation.

$$\Delta i \propto \Delta t_{Lorentz}$$

Would not the universe as a whole display the same dilation effect?

The total force on every/any particle is equal at all points, but as the points accelerate inwardly, they begin to obey the Lorentz contraction phenomena and "baryonic" mass begins to appear. Now, the universe as a whole has achieved a certain equilibrium, (the Lorentz space has reached limits). Normal matter, a negative pressure which is the curvature known as baryonic mass, obeys these limits. The Holographic constant mentioned above is "seen" as mass by the universe at large, that surface which must be occupied, in order for the universe to "recognize" mass.

The universe itself, as a whole evidences the above formula, with the additional condition of representing the clearly unique result below.

$$r_u = \sqrt{M_U} = \frac{c^2}{2G} = \frac{2GM_U}{c^2}$$

This unique result has been noted by both Hawking and Susskind (in passing) as a basis solution, though it was not pursued by either. No other mass value approaches this unique characteristic.

## Conclusion

If we acknowledge that space and time are exclusively frame dependent (2) (they have no intrinsic properties whatsoever, but only relative value), then in a black hole series, expansion out of one frame is contraction into the other frame. An understanding of the singularity of space and of inertia is eminent.

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