Charged Particle Radiation Power at the Planck Scale One Force and One Power?

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Abstract

In this paper we show that the Larmor formula at the Planck scale is simply the Planck power multiplied by $\frac{1}{2\pi}$. The Larmor formula is used to describe the total power radiated by charged particles that are accelerating or decelerating. Haug (2016b) has recently shown that the Coulomb's electrostatic force is the same (at least mathematically) as the gravitational force at the Planck scale. The findings in this paper strengthen the argument that electricity is not so special and that at the Planck scale, we likely only have one force and thereby only one power as well.

Key words: Larmor formula, radiation by charged particles, electric power, Planck power, unified forces, quantum realm.

1 Planck Power

The Planck power is normally given by

$$P_p = \frac{c^5}{G} \tag{1}$$

where G is Newton's gravitational constant and c is the well known round-trip speed of light. Haug (2016a,c) suggests that the gravitational constant should be written as a function of Planck's reduced constant[1]

$$G_p = \frac{l_p^2 c^3}{\hbar} \tag{2}$$

This way of writing Newton's gravitational constant does not change the value of the constant. If we know the Planck length, then the gravitational constant is known, or alternatively (and more practically) we can calibrate the Planck length based on empirical measurements of the gravitational constant. Based on this, the Planck force (without changing its value) can be rewritten as

$$\begin{aligned} P_p &= \frac{c^5}{G_p} \\ P_p &= \frac{c^5}{\frac{l_p^2 c^3}{\hbar}} \\ P_p &= \frac{\hbar}{l_p}\frac{c^2}{l_p} \end{aligned} \tag{3}$$

We will see that rewriting the Planck power in this form is important for understanding the relationship with Larmor's charged particle radiation formula at the Planck scale.

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[1]Here we use a notation more familiar to modern physics.

2 The Larmor Formula in Planck Form

In 1897, the Irish physicist Joseph Larmor[2] published a formula that can be used to calculate the total power radiated by charged particles that are accelerating or decelerating. Charged particles that do not accelerate or decelerate do not radiate energy. In the notation of modern physics,[3] the formula is typically given by

$$P = a^2 \frac{q^2}{6\pi\epsilon_0 c^3} \tag{4}$$

where q is the charge of the particle and a is the acceleration

$$a = \frac{F}{m}, \tag{5}$$

and ϵ_0 is the electrical constant given by

$$\epsilon_0 = \frac{1}{\mu_0 c^2} = \frac{1}{4\pi \times 10^{-7} \times c^2}, \tag{6}$$

and c is the well known round-trip speed of light.[4]. The Larmor formula is valid for charged particles moving at velocities much slower than that of the speed of light $v << c$. However, the formula can easily be rewritten in relativistic form to hold for charged particles traveling at high velocities as well. Here we will limit ourselves to the radiation from low velocity charged particles.

Haug (2016a,b) has recently shown how a series of the Planck unities can be rewritten in a simpler form. The Planck mass is given by $\frac{\hbar}{l_p}\frac{1}{c}$ and the Planck force is given by $\frac{\hbar}{l_p}\frac{c}{l_p}$. Based on this we have

$$a_p = \frac{F_p}{m_p} = \frac{\frac{\hbar}{l_p}\frac{c}{l_p}}{\frac{\hbar}{l_p}\frac{1}{c}} = \frac{c^2}{l_p} \tag{7}$$

If we input the numerical values for c and l_p into the formula, we will see this is an incredible acceleration of 5.56082×10^{51} m/s. In 1984, Scarpetta had already predicted this as the maximum possible acceleration. At first glance such a high acceleration seem impossible, as this would mean reaching a speed much faster than the speed of light within one second of acceleration. However, the reason is that a Planck mass only accelerates this much for one Planck second. A Planck second is given by $t_p = \frac{l_p}{c}$, and from this we can find the speed of the Plack mass after one Planck second of Planck acceleration.

$$a_p t_p = \frac{c^2}{l_p} \times \frac{l_p}{c} = c = 299,798,458 \text{ m/s} \tag{8}$$

This basically means that the Planck mass is accelerated to the speed of light and thereby converted into energy (radiation), and radiation is exactly what we will look at in this paper. Further, the Planck charge is given by $q_p = \sqrt{\frac{\hbar}{c}}\sqrt{10^7}$. Based on this, we can rewrite the Larmor formula in Planck form:

[2]Joseph Larmor was the first to introduce time dilation and combine it with the FitzGerald and Lorentz length contraction. He was also the first to come up with a mathematical transformation that was consistent with the Michelson Morley experiment and its ether-based theory.

[3]See for example Cottingham and Greenwood (1991) and Purcel and Morin (2013).

[4]Be aware that only the round-trip speed of light has been well tested and understood, not the one-way speed of light.

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\begin{aligned}
P &= a_p^2 \frac{q_p^2}{6\pi\epsilon_0 c^3} \\
P &= a_p^2 \frac{\sqrt{\frac{\hbar}{c}}\sqrt{10^7}\sqrt{\frac{\hbar}{c}}\sqrt{10^7}}{6\pi\epsilon_0 c^3} \\
P &= \left(\frac{F}{m}\right)^2 \frac{\sqrt{\frac{\hbar}{c}}\sqrt{10^7}\sqrt{\frac{\hbar}{c}}\sqrt{10^7}}{6\pi\frac{1}{4\pi\times10^{-7}\times c^2}c^3} \\
P &= \left(\frac{c^2}{l_p}\right)^2 \frac{\frac{\hbar}{c}}{2\pi c} \\
P &= \frac{c^4}{l_p^2}\frac{\frac{\hbar}{c}}{2\pi c} \\
P &= \frac{1}{2\pi}\frac{\hbar}{l_p}\frac{c^2}{l_p} \qquad (9)
\end{aligned}
$$

In other words, the radiation power given by Larmor is nothing other than $\frac{1}{2\pi}$ times the Planck power (formula 3). The reason it is multiplied by $\frac{1}{2\pi}$ is likely because the Larmor formula is derived based on the radius of a sphere. As l_p is the Planck length, then multiplying by 2π, we get the Planck radius. This strengthens our view that the radiation related to electrostatic charge is nothing "special". Based on the recent findings by Haug (2016b) in combination with this new observation, we strongly suspect that there is only one force, and thereby naturally one power at the depth of reality. Hopefully this is another small step in the right direction for a unified theory in physics.

3 Conclusion

We conclude that the Larmor charged particle radiation formula neatly fits into the picture that we have seen at the very bottom of the rabbit hole. That is to say, at the Planck scale, there is likely only have One Force and thereby also only One Power. We are ending this paper on a light note: May the One Force and One Power be with you!

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