Spacetime Analysis

This email is going to primarily deal with proving that spacetime has a tremendous quantum mechanical energy density which fills the universe and is responsible for all particles, fields and forces. However, before I launch into that, I want to comment on a part of your response. You said, "You go on to ascribe relations between the gravitational and electromagnetic forces to these excitations, and note that there is a relationship between these forces at some particular length scale…. – both the electromagnetic and Gravitational forces are inverse square. This means it is easy to find a relation between their coupling constants at ALL length scales. Just divide one force by the other. This leaves a dimensionless relationship between them which is just a big (or a small) number..

Your key points are not correct. It is true that the equation $\underline{F_g} = \underline{F_E}^2$ assumes a particular length scale, but the following equations do not because the dimensionless number N is an arbitrary separation distance expressed as the number of reduced Compton wavelengths.

$$\frac{F_g}{F_E N} = \frac{F_E N}{F_p}$$

$$\left(\frac{F_g N^2}{F_p}\right) = \left(\frac{F_E N^2}{F_p}\right)^2$$

It is also possible to test the validity of your statement, "It is easy to find a relation between their coupling constants at ALL length scales. Just divide one force by the other. This leaves a dimensionless relationship between them which is just a big (or a small) number." We will assume two hypothetical particles each with mass m and Planck charge q_p. The gravitational force F_g and the electrostatic force F_E are given below. Then as you suggest we divide F_g by F_E.

$$F_g = \frac{Gm^2}{r^2}$$

$$F_E = \frac{q_p^2}{4\pi\varepsilon_o r^2} = \frac{\hbar c}{r^2}$$

Note: $\hbar c = 3.16 \times 10^{-16}$ Joule meter (a constant)

$$\frac{F_g}{F_E} = \frac{Gm^2}{\hbar c}$$

Therefore, the ratio F_g/F_E is dimensionless, but it is not "just a big (or a small) number" as you suggest. This ratio contains an m^2 term which means that it is not a constant. In fact, this illustrates why a relationship between these two forces is so difficult to find. The gravitational force scales with mass/energy and the electrostatic force does not. A muon has the same charge (same force) as an electron even though a muon has 207 times more mass/energy.

The generally accepted model of the transfer of the electromagnetic force is virtual photon messenger particles. Gravity is usually considered to be either a purely geometric effect or transferred by gravitons. Suppose that we compare a force transferred by virtual photons and a different force transferred by either gravitons or the geometry of space. No one has postulated a fundamental relationship between virtual photons and either gravitons or the geometry of space. Therefore, if these models are correct, there should not be any fundamental relationship between the electrostatic force and the gravitational force. Einstein worked for 30 years and he did not find any fundamental relationship. This convinced many scientists that there was no fundamental relationship between gravity and the electromagnetic force.

Now suppose that a new theory comes along that proposes that all particles are rotating quantized waves existing in a sea of spacetime dipole waves. This sea of waves is finite and therefore has boundary conditions. This means that new waves which propagate in this medium similar to sound waves propagating in a sea of small amplitude waves should show some distortion. A perfect sine wave would become a distorted sine wave which can be expressed as a linear term and a nonlinear term. The ratio between the linear and nonlinear terms to a first approximation should scale with amplitude squared. The prediction emerges that there should actually be a connection between the electrostatic force (the linear term) and the gravitational force (the nonlinear term). Furthermore, the connection should scale with amplitude squared and scale proportional to the size of the rotating particle. This means that the separation distance between two particles should be expressed using the particle's natural unit of length which is the rotational radius ($\lambda\!\!\!\!-_c$). A simple calculation shows that these are correct predictions. Eureka!

Spacetime Field: Now I am going to give the promised proof that spacetime is a sea of quantum mechanical small amplitude waves also known as dipole waves in spacetime These waves are a different form of energy than fermions and bosons. They are the basis of what we have been calling fields. What is a field? John Gribbin[1] describes a field as a physical quantity that has a value for each point in space and time. John Archibald Wheeler says a field "occupies space - It contains energy. Its presence eliminates a true vacuum."[2] Richard Feynman said, "A field has such familiar properties as energy content and momentum, just as particles can have".[3] Albert Einstein equated "field" to "physical space".

The standard model is a field theory with about 17 named fields. Fundamental particles are described as "excitations" of their associated "fields". Therefore, even the standard model has the vacuum filled with fields. Since particles are excitations of fields, and fields exert forces, it might be said that all particles and forces are derived from fields. In other words, the standard model implies that "the universe is only fields." It is a short jump from this to "the universe is only spacetime".

There is no doubt that spacetime is not just an empty void. The Lamb shift, Casimir effect, the anomalous magnetic dipole moment, spontaneous emission, virtual particle pair production and vacuum polarization all require that the vacuum has physical properties that are inconsistent with an empty void. Zero point energy and QED calculations all require that the vacuum has an energy. An empty void would not have a universal speed limit or would not have other constants such as G, ħ, and ε_o. However, there is also numerous reasons to believe

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[1] John Gribbin (1998). *Q is for Quantum: Particle Physics from A to Z*. London: Weidenfeld & Nicolson. p. 138. ISBN 0-297-81752-3

[2] John Archibald Wheeler (1998). *Geons, Black Holes, and Quantum Foam: A Life in Physics*. London: Norton. p. 163.

[3] Richard P. Feynman (1963). *Feynman's Lectures on Physics, Volume 1*. Caltech. pp. 2–4

that the vacuum does not have energy in excess of about 10^{-9} J/m^3 which is associated with dark energy. Matter can propagate at any speed less than the speed of light without encountering any friction or drag. Also general relativity teaches that energy in any form creates gravity. These two points will be addressed later.

General relativity and specifically our knowledge of the properties of gravitational waves gives a great deal of insights into the properties of spacetime. Gravitational waves are something like transverse acoustic waves that are propagating in the medium of spacetime. The same way that it is possible to obtain information about the properties as an acoustic medium by characterizing its acoustic properties, so also information about the underlying properties of spacetime can be obtained by studying gravitational wave equations and characteristics. Even though gravitational waves have not been directly detected, they have been indirectly observed. The Hulse–Taylor binary star system has been observed for over 30 years. Over that time it has been observed to loose energy because it is radiating gravitational waves. The predicted energy loss to gravitational waves agrees with the observed energy loss to an accuracy of about 0.2%. Currently this binary star system is radiating about 10^{25} watts of gravitational wave power.

Spacetime acts like a very stiff elastic medium. Very high powers can be transmitted by waves which produce a very small distortion of spacetime. The impedance of spacetime $Z_s = c^3/G \approx 4\text{x}10^{35}$ kg/s is known to experts working on gravitational wave detection, but this important constant is virtually unknown outside this field. If both stars of a binary star system have the same mass and are separated by R, then the equation for the radiated power is simplified to:

$$\frac{dE}{dt} = 12.8\ \frac{G^4 m^5}{c^5 R^5}$$

For example, the Hulse–Taylor binary system is radiating about 10^{25} watts of gravitational waves. However, the highest power gravitational waves when two of the same size black holes are about to merge ($R \approx R_s$ = Gm/c^2). The power radiated into gravitational waves the instant before the two black holes merge is:

$$\frac{dE}{dt} = k\ \frac{c^5}{G} \approx \text{ Planck power} \approx 10^{52} \text{ watts}$$

If you calculate the maximum energy density (U) of the gravitational waves at this instant, it is: $U = k\, F_p/R_s^2$.
For example, if the two of the same size black holes were about to merge to form a larger black hole with a Schwarzschild radius of 10 km, then for an instant the energy density of the gravitational waves leaving the new event horizon would be a numerical constant times 10^{42} J/m^3. Clearly, spacetime can possess tremendous energy density if gravitational waves are present.

Think about the physics of this. Somehow spacetime is able to possess observable energy density in excess of 10^{40} J/m^3 when it is being modulated by gravitational waves. Is it reasonable to think that spacetime is an empty void when there are no gravitational waves present? What is being accelerated and compressed by the gravitational waves? The proposed answer is that spacetime always possesses quantum mechanical energy in the form of Planck length/time displacements of spacetime predominantly at Planck frequency. These small amplitude waves have no angular momentum and are the most perfect superfluid possible. They are undetectable to us as individual waves, but their presence gives spacetime its ability to propagate gravitational waves. The gravitational waves slightly distort the dipole spacetime waves causing the frequency to slightly shift. This gives spacetime its very still elasticity. The gravitational waves carry angular momentum, therefore the modulation of this spacetime field energy also introduces angular momentum and a portion of the energy density becomes observable to us.

In my Aether paper I do a calculation where I take a gravitational wave (Eq. 3) and calculate the implied energy density of the spacetime field. Equation 5 in this paper shows the result of this calculation. The energy density encountered by a gravitational wave with angular frequency ω or reduced wavelength ƛ is:

$$U_i = \mathrm{k}\,\frac{F_p}{ƛ^2} = k\left(\frac{\omega^2}{\omega_p^2}\right)U_p$$

The symbol U_i is called "interactive energy density" because the energy density encountered by gravitational waves is frequency dependent. This is understandable because the fluctuations in spacetime are predominantly at Planck frequency. Therefore, there is a frequency mismatch when a gravitational wave is at a lower frequency. In particular, notice that the energy density of any size black hole is $U_{bh} = k\,F_p/R_s^2$ (where $F_p = c^4/G$) and the interactive energy density of spacetime is $Ui = kF_p/ƛ^2$. A gravitational wave with reduced wavelength ƛ encounters the same energy density as a black hole when $ƛ = R_s$. This is reasonable because a black hole forms when all the spacetime energy at a particular frequency range is commandeered by energy which possesses angular momentum.

The Aether paper also gives a numerical example of a gravitational wave with angular frequency of $\omega = 1$ s^{-1} and intensity of 1 w/m^2. Such a wave would distort the distance between points by about 10^{-18} meters/meter. Scientists normally just say that spacetime is a very stiff elastic medium and do not attempt to understand the underlying physics. The example in the Aether paper shows that this gravitational wave is actually encountering interactive energy density of about 10^{27} J/m^3 and is interacting with a volume of spacetime equal to $ƛ^3$ so when $ƛ = 3\text{x}10^8$ m, then the wave is accelerating about $3\text{x}10^{52}$ Joules of dipole waves. These have inertia which then explains the small displacement produced by the gravitational wave. This brief summary is incomplete, so to fully understand this point it is necessary to consult the Aether paper.

Matter can propagate through the sea of dipole waves that fill spacetime because all fundamental particles are just units of quantized angular momentum propagating in the spacetime field. This is not a new wave being introduced into a volume such as a propagating gravitational wave or a propagating electromagnetic wave. A fundamental particle is like a rotating vortex. It is only stable at certain frequencies as explained in the foundation paper and the book. Also, the energy in the vacuum fluctuations does not create gravity. Instead, this homogeneous distribution of waves is what is being distorted when matter is introduced into a volume. It is possible to calculate how matter causes curved spacetime with this model.

Finally, the proposed charge conversion constant shows that photons also experience the same impedance (c^3/G) as gravitational waves. Photons impart quantized angular momentum to the dipole waves in spacetime which lack angular momentum and makes this energy observable. This makes the surprising prediction that there should be a maximum possible intensity for light with reduced wavelength $\lambda\!\!\!^{-}$. The maximum allowed intensity is the intensity which equals the interactive energy density $U_\mathrm{i} = F_p/\lambda\!\!\!^{-2}$ when the light is confined in the smallest possible volume which is a constant times $\lambda\!\!\!^{-3}$. The Foundation paper shows that this is a correct prediction because a black hole would form at this maximum allowed energy density for volume $\lambda\!\!\!^{-3}$.

In conclusion, both quantum mechanics and general relativity have many mysteries. These mysteries become conceptually understandable when you adopt the perspective that spacetime is filled with small amplitude vacuum fluctuations which has quantifiable energy density. This is the basic building block of everything in the universe. All that is necessary to make this energy observable is to introduce quantized angular momentum. For example, this happens in particle accelerators. As Nobel Laureate, Robert Laughlin explains it, "Large particle accelerators have now led us to understand that space is more like a piece of window glass than ideal Newtonian emptiness. It is filled with 'stuff' that is normally transparent but can be made visible by hitting it sufficiently hard to knock out a part. The modern concept of the vacuum of space, confirmed every day by experiment, is a relativistic ether. But we do not call it this because it is taboo."

John M.