On the inherent dynamics of the fabric of
Spacetime

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Abstract

Motivated by $E = tc^5/G$ where $t$ is time, we shall propose that space-
time itself can have a matter-like behaviour, being a source for a new
fundamental field, which turns out to have the dimensions of force and
power. Accordingly a rough explanation of the expansion of the universe
is presented.

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1 My perspective on physics

Some of my works rely heavily on attributing new fundamental properties
to particles of matter. This approach comes from *induction* on sucessful
physics, mainly special relativity. Whether this induction is objectively
justified is more of a question of experimental physics and my commit-
ment as a rational theoretical physicist is not to worry much about these
matters, but pave the way for novel progress in physics –especially in its
current stagnation–, to *push the frontiers at almost any cost and sacri-
ifice*. There is little doubt that even if some of my work turns out to be
valuable, it will need ‘pruning’ and reconsideration.

This perspective of mine relies on the following core principles when they
are considered and reflected upon together as a whole,
Principle 1. Einstein Constancy Principle\(^1\) By induction on Einstein’s principle of constancy of velocity of light, first limiting ourselves not to use the Planck constant\(^2\), we have the following maximums

- Maximum mass flow (mass/time) = \(\frac{c^3}{G}\)
- Maximum current (charge/time) = \(c^3 \sqrt{\frac{4\pi\epsilon_0}{G}}\)
- Maximum temperature flow (temperature/time) = \(\frac{c^5}{k_B G}\)

Then, taking Planck constant into account:

- Maximum temperature = \(\sqrt{\frac{\hbar c^5}{G k_B}}\)
- Maximum frequency = \(\sqrt{\frac{c^5}{\hbar G}}\)
- Maximum acceleration = \(\sqrt{\frac{c^7}{\hbar G}}\)
- Maximum entropy flow rate (entropy/time) = \(k_B \sqrt{\frac{c^5}{\hbar G}}\)

Principle 2. Fundamental Properties of Matter Two of the base units of measurement, which we take to be length (space), time, mass, electric charge, temperature are characteristic properties of matter (electric charge and mass). By induction on this consideration to each base unit we associate a characteristic property of matter\(^3\). Accordingly single particles possess space, time, mass, electric charge and temperature.

Principle 3. Extra dimensions Two of the base units are the physical dimensions of the manifold on which physics takes place (one which is currently thought to be spacetime). By induction, we propose that To each base unit, there corresponds at least one\(^4\) physical dimension.

\(^1\)This principle itself can be considered as a consequence of a principle of finiteness/compactness. But I have not yet successfully formulated such principle.

\(^2\)This is because I feel dubious about Planck units.

\(^3\)There might be a twist about temperature as it might not be a fundamental property, but a fundamental field. It is more compelling to take entropy instead to be a characteristic property of matter. But this is more of a convention issue which has a historical reason. Both alternatives are considered in [1] and [2].

\(^4\)‘At least’ takes care of the fact that there are three dimensions associated to length. Whether this case might repeat for other new dimensions is a matter which needs to be more reflected on.
Principle 4. Two of the base units (mass and electric charge) are sources for fundamental interactions of gravity and electromagnetism. By induction, we propose that To each fundamental property of matter (base unit) there corresponds a fundamental interaction (force).

Principle 5. By induction on $E = mc^2$ we propose that Each fundamental property of matter is equivalent to energy.

Application of this principle to electric charge and temperature is already done elsewhere[1][2][3]. In this paper we propose the final application: Spacetime-Energy equivalence.

2 Space and time as material entities

2.1 Spacetime-Energy equivalence

According to Principle 5 we propose that spacetime itself can have a matter-like behaviour and therefore possess energy, given by

$$E = \frac{c^4}{G}(l + ct).$$

(1)

By comparing (1) with $E = mc^2$ we conclude that $c^4/G$ and $c^5/G$ must be maximums (principle 1). Application of principle 2 and 5 thus yields

Corollary. Energy of a free\(^5\) ‘chunk’ (particle) of space and time

$$E = lF_P$$

(2)

$$E = tP_P$$

(3)

where $P_P := \text{Planck energy/Planck time, i.e. Planck Power.}$

Mathematical implementation of Principle 1 requires introduction of the following factors\(^6\)

$$\alpha = \frac{1}{\sqrt{1 - \frac{F_P}{P_P}}}$$

(4)

$$\xi = \frac{1}{\sqrt{1 - \frac{P_P}{P_P}}}$$

(5)

Together with the previous corollary, they yield

Corollary. Energy of a forced ‘chunk’ (particle) of space and time

$$E = l\alpha F_P = \frac{lF_P}{\sqrt{1 - \frac{F_P}{P_P}}}$$

(6)

$$E = t\xi P_P = \frac{tP_P}{\sqrt{1 - \frac{P_P}{P_P}}}$$

(7)

\(^5\)Free means not forced, i.e. $F = 0$.

\(^6\)Relevant to the subject of this paper. Expectedly there is a similar factor for each maximum of principle 1.
2.2  Rough explanation of the Expansion of the Universe

According to equations (2) and (3), huge amounts of energy can create spacetime itself, and vice versa, destroying spacetime (space and/or time) creates huge amounts of energy. We already know that Dark matter/energy considerations indicate that the conservation of energy in the universe as a whole does not hold. As the universe is expanding, (2) and (3) imply that there are some sources which are creating huge amounts of energy. These energies are transformed to spacetime and hence the universe expands. It might be tempting to say that these energies come from 'outside' of the universe as a whole, but that is meaningless, as Smolin remarked, there is only one universe and we are stuck inside it.

3  Inherent dynamics of flat spacetime

If we posit that a particle possesses a fundamental property, it is an inductive conclusion that the property must be the source of a new interaction (principle 4); for example we know that mass is a fundamental property and it is the source for gravitational force, or electric charge is a fundamental property and it is the source for electric force. Therefore according to our fundamental proposal that spacetime itself can have a matter-like behaviour, it must as well be the source for a new force which we now proceed to find.

3.1  Introduction: A ‘recipe’

Let us begin by the observation that if we add mass to the source term (current density) of electromagnetism, we can construct the gravitational potential and from the (already known) field equations (of electromagnetism) we are led to the Poisson equation for gravity. To see this, we first construct the five-current

\[ J^\mu := (c \sigma_0 \mu, c \rho, J) \]

where \( \mu \) is mass density (per unit volume), \( \rho \) electric charge density and \( J \) electric current density and \( \sigma_0 := \sqrt{4\pi\epsilon_0 G} \).

To construct the five-potential from five-current, we first note how the four-potential

\[ A^\mu := (\varphi/c, A) \]

is constructed from the four-current: divide the component of potential by the coefficient of the corresponding component of current, i.e. divide the electric potential by \( c \), therefore the candidate for the gravitational component of current density would be \( \phi/(c \sigma_0) \), where \( \phi \) is the (Newtonian) gravitational potential. To validate this candidate it only remains to verify that \( \phi/(c \sigma_0) \) has the units of Volts/c, which indeed it has. It only remains to observe that the field equation

\[ \Box A^\mu = -\mu_0 J^\mu \]
yields
\[
\left( \frac{1}{c^2} \frac{\partial^2}{\partial t^2} - \nabla^2 \right) \phi = -4\pi G\mu
\]
assuming the field is time-independent, we are led to the Poisson equation for gravity
\[
\nabla^2 \phi = 4\pi G\mu;
\]
therefore we find that the aforementioned recipe is justified: it works for electromagnetism and gravity, so why should it not work for any new force? therefore we do an epistemological extrapolation and assume that ‘the recipe’ always works provided it is applied with a sufficiently deep understanding of the matter at hand. If any of the equations arrived at by the proper application of this recipe turn out to be empirically refuted it will be necessary to revise it; until that time, we maintain an instrumentalist view regarding the validity of the recipe.

3.2 Field equations of the ‘Dark Force’
Assuming that spacetime itself has a matter-like behaviour, following ‘the recipe’ of the previous section, we shall now find the potential responsible for the inherent dynamics of the spacetime. First we find the potential associated to time. Applying the fundamental assumption that time itself can be a material source, we add time to the current density fourvector of electromagnetism, to get the five-current
\[
J^\mu := (c^4 \sqrt{\frac{4\pi\epsilon_0}{G}}, \tau, c\rho, J),
\]
where \( \tau \) is time density per unit volume of space (SI units, seconds/meter\(^3\)). Applying the recipe would yield the five-potential
\[
A^\mu := \left( \frac{\xi}{c^4} \sqrt{\frac{G}{4\pi\epsilon_0}}, \frac{\varphi}{c}, A \right),
\]
where we do not yet know what is \( \xi \), i.e. the potential associated with the dynamics of time. To find the dimensions of \( \xi \), we apply dimensional analysis,
\[
\left[ \frac{\xi}{c^4} \sqrt{\frac{G}{4\pi\epsilon_0}} \right] = \text{volt} \left[ \frac{c}{\text{s}^2} \right],
\]
which yields that \( [\xi] = [\text{power}] \) (Watts in SI), so we rename it to \( P \); but it need not be defined as the conventional power is defined in classical physics. From the wave equation of electromagnetism \( \Box A^\mu = -\mu_0 J^\mu \) now results that the wave equation governing \( P \) is
\[
\Box P = -\frac{4\pi c^6}{G} \tau.
\]
A similar rationale would show that the potential associated with space has the dimensions of force, governed by the following wave equation
\[
\Box F = -\frac{4\pi c^4}{G} A,
\]
where $\Lambda$ is supposed to be *space density per unit volume of space*! (SI units, $\text{meter/meter}^3 = \text{1/meter}^2$), which has the same units with the Cosmological constant hence the symbol $\Lambda$. Note that since here $\Lambda$ is a vector, it need not the same in all directions of space i.e. no assumption of isotropy of the universe.

Normalising the constants, we define

$$F^\mu =: (P/c, F)$$ \hspace{1cm} (8)

$$\Lambda^\mu =: (\tau c, \Lambda)$$ \hspace{1cm} (9)

And the field equations would be

$$\partial_\nu D^\nu = \frac{4\pi c^4}{G} \Lambda^\nu$$ \hspace{1cm} (10)

where

$$D^\mu = \partial_\mu F^\nu - \partial_\nu F_\mu$$ \hspace{1cm} (11)

It is possible, that this is a new fundamental force of nature, extremely powerful (even more powerful than electromagnetism and gravity) because of the hugeness of the right-hand-side factor $c^4/G$.

**References**

