INVITED PAPER

Cosmic system dynamics: a cyberneticist's perspective on gravitation.

[Kybernetes Vol. 40 Issue 9/10, pp 1319-1330, Nov. 2011]

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ABSTRACT

Purpose

This paper presents a novel perspective on the interplay of forces that govern the dynamics of the massively complex multi-body system that is our physical universe. It offers a consistent, coherent and complete rationale for the phenomenon referred to as 'gravitation'. This includes notably, for the first time, an explanation for the mechanism by which "matter tells space how to curve and curved space tells matter how to move", also possible causal explanations for the various outcomes of Einstein's equivalence principle.

Design/methodology/approach

Starting from the well-supported premise that elementary particles are formed from closed-loop electromagnetic energy flows, the likely impact of such constructs on the behaviour of large-scale dynamic systems is analysed from first principles.

Findings

Gravitation is shown to be a natural consequence of such a construct. The warping of space in the presence of gravitating mass, consistent with the view presented by general relativity, is shown to relate to a clearly comprehensible physical structure with a well-defined causation. Possible explanations are offered for: gravitational time dilation; gravitational red shift; gravitational potential energy; slowing and bending of light in a gravitational field.

Research implications

This novel perspective opens a wide range of potential avenues of innovative research, both pure and applied.

Practical implications

A variety of new technologies may prove to be open to development, notably in the aerospace field. Antigravity technologies, whilst amenable to investigation and possible development, may prove highly energy-intensive.

Originality/value

Totally original and of very significant potential value in various respects.

Keywords: System dynamics, Cybernetics, Gravitation, General relativity, Quantum gravity, Aerospace industry.

Dedication

This paper is dedicated to the memory of that Grand Master of cybernetics, Gordon Pask. His understanding of the wave-structure of particles placed him well ahead of his time.

1. Introduction

The dynamics of the highly complex system that is our universe are determined by the effect referred to as 'gravitation'. Opinions are divided as to whether the celestial engineering governing that complexity is the result of random processes or some form of higher intention. Either way, from a cybernetic viewpoint explanation is still very much needed for the precise mechanism by which countless clusters of galaxies, and the innumerable star systems in each of them, are each maintained in a state of self-regulating dynamic equilibrium.

General relativity defines gravitation in terms of curvature of spacetime, however what this means in material terms is not defined. Rather it is explained either purely mathematically or by analogy, *e.g.* as a 'dent' in spacetime caused by a massive body such as a star, around which a satellite body such as a planet follows a regular path.

Likewise the means by which material objects create that curvature has yet to be explained. The present level of understanding of this phenomenon is well expressed by cosmologist John Wheeler's paraphrasing of this fundamental tenet of general relativity: "Matter tells space how to curve and curved space tells matter how to move." Whilst this provides a useful mathematical model, the reciprocal roles of 'gravitating mass' and 'gravitation' are generally circularly defined in terms of each other.

Difficulties also exist in respect of the hypothetical elementary particle generally regarded as mediating gravitational effects. Whilst the concept of the *graviton* offers an element of consistency with quantum field theory, gravitation is itself nonrenormalizable in this form (Feynman *et al.*, 1995). This means that at high energy states infinities that arise due to quantum effects cannot be eliminated, leading to meaningless results.

Furthermore, gravitons have not yet been detected, nor is detection of individual gravitons a realistic possibility (Dyson, 2004; Rothman and Boughn, 2006). Projects currently underway to detect gravitational waves – coherent multi-graviton states – depend on prior assumption of the existence of such waves (Ando *et al.*, 2002; Sigg, 2002; Wilke *et al.*, 2004; La Penna *et al*., 2007). It's possible that results deemed to relate to such waves may in fact relate to some other aspect of reality, notably to the true nature of gravitational effects, if the current view is incorrect or incomplete.

Conventional general relativity, then, is recognized as being deficient to some degree in its inability to effectively handle situations such as black holes or the original big bang event, leaving a need for a more comprehensive theory (Hawking and Israel, 1979). Given also the lack of experimental evidence of the existence of gravitons, the question then arises as to whether an alternative perspective on the whole issue of gravitation may be worthy of serious consideration.

Following the principle of Occam's razor – "Do not multiply entities unnecessarily" – it's also worth considering whether gravitons are needed at all, or indeed even gravitation itself as an effect in its own right distinct from all others. It may be, rather, that observed phenomena currently attributed to gravitation are fully explainable in terms of other, more thoroughly characterised, effects.

Clearly any alternative explanation of gravitational effects would need, in addition to fully addressing every detail of gravitational attraction, to provide clear answers to three long-standing questions relating to this phenomenon:

(1) Why is gravitation always attractive, never giving rise to repulsion?
(2) Why is gravitation many orders of magnitude weaker in its effect than any of the other fundamental forces?
(3) Why is gravitation infinite in the extent of its effects?

Proposals offered to date in respect of these issues would appear to be somewhat speculative.

It is in fact fully possible to offer a complete rationale for gravitational phenomena without reference to any gravitational particles or waves. This rationale is fully compatible with the concept of 'curved spacetime' and indeed provides a cogent explanation for the basis of that 'curvature' as embodied in the principles and equations of general relativity. It further provides clear answers to the three questions posed above. Last, but by no means least, it offers a way forward in addressing key fundamental issues in respect of the nature of space and time.

That rationale is the subject of the remaining sections of this paper.

2. Electric charge

Electrically charged objects experience forces of mutual repulsion in cases of like charge and mutual attraction in cases of unlike charge. In any case where there is zero net charge carried by either or both objects there is considered to be no electrical effect acting between them.

It's also considered to be the case that both electrical and magnetic field effects may be blocked by suitable material obstructions, for example the magnetic field in a solenoid is regarded as being contained by the solenoid structure. However it is now generally accepted that the Aharonov-Bohm effect offers clear evidence of influence by both electrical and magnetic potentials in regions beyond such apparent barriers (Aharonov and Bohm, 1959 & 1961; Osakabe *et al.*,1986; *etc*). In other words, at the quantum level electromagnetic potential is unlimited in its range irrespective of any material obstacles (though of course it would be expected to diminish with distance in accordance with the inverse square law).

Another material consideration is the apparent fact that charge is not in any way related to mass. For example, an electron carries an equal charge (of opposite sign) to a proton, even though the latter is several orders of magnitude more massive than the former; also a neutron carries no charge at all, despite having similar mass to a proton.

Both of these observations merit further consideration. Whilst a proton carries unit net charge, it is comprised of three quarks whose total unsigned charge amounts to 5/3 units. A neutron is likewise made up of three quarks with an unsigned total charge of 4/3 units – in its composition it is not electrically neutral.

Taking that observation one step further, a free neutron, or a neutron involved in β-decay of an atom, decays into a proton plus an electron by the simple expedient of one of its negatively charged quarks splitting into a positively-charged quark and an electron (plus an electron antineutrino). This demonstrates that even a quark has a sub-structure incorporating both types of charge.

Count Louis de Broglie's doctoral thesis won him a Nobel prize for his proposal of a wavelike property in matter (de Broglie, 1925), a characteristic confirmed experimentally just two years later (Davisson and Germer, 1927). A wide body of research published since that time implicitly supports the hypothesis that particles of matter are formed from closed-loop photons of electromagnetic energy:

(a) Photons and elementary particles have been shown to be interchangeable (Landau and Lifshits, 1934; Cabibbo and Gatto, 1961; Cabibbo *et al.*, 1962; Di Vecchia and Greco, 1967; Barbiellini *et al.*, 1974; Schwitters and Strauch, 1976; Baldini *et al.*, 1979; Cooper, 1988; Bernardini, 2004; Ginzburg, 2006).

(b) The phenomenon of *zitterbewegung*, variation at the speed of light of an electron's position about its mean path as first identified by Schrödinger (Schrödinger, 1930), has been shown to be a demonstrable physical feature of the composition of that particle (Catillon *et al.*, 2008). This is clearly indicative of a cyclic component in the fundamental structure of an electron (Huang, 1952; Barut and Bracken, 1981; Hestenes, 1990).

(c) Theoretical research has shown that a cyclic-photon model of particulate matter accounts for various quantum characteristics of an electron (Williamson and van der Mark, 1997) as well as providing a basis for all verifiable tenets of special relativity (Blackwell, 2011).

Both of those last two studies support the premise that the static charge on a particle is a macroscopic external manifestation of the circulating time-varying electromagnetic fields that form the particle. They also both present the view that a specific charge state is produced by a circularly polarized closed-loop photon.

This raises the likelihood that a closed-loop photon circularly polarized in the opposite sense would give rise to a charge of the opposite type (Blackwell, 2011). By extension, a particle formed from a photon (or configuration of photons) that can be resolved into a combination of left and right circularly polarized photon elements (as all photons can) would give rise to a mix of positive and negative charge, seen as a net charge that is the signed summation of those parts.

This model of an elementary particle, then, leads naturally to the conclusion that the net charge on a particle results from the difference between elements of charge generated by the left and right circularly polarized components of the photon(s) forming that particle. The sign of that charge would then depend on the sense of the predominant circular polarization type. Since the mass of a particle is proportional to its energy content and energy content includes both left and right circularly polarized components without regard to sense, it's clear that net charge will not in general be proportional to mass.

3. Charge and gravitation

None of the above would be of great significance in relation to gravitation if it were indeed the case that forces of attraction between unlike charges and those of repulsion between like charges are equal as well as opposite, as is generally believed. However, all of the evidence gathered over several centuries points to the attractive force being marginally greater than the repulsive force.

That marginal difference is, arguably, the effect that we have chosen to categorise as distinct from electrical interactions – the effect we refer to as 'gravitation'.

Science has opted to attribute a separate label to gravitation because particles which have seemingly no electric charge still experience that attractive influence. Having taken this step, then, on disregarding that minute 'gravitational' attraction, the forces of attraction and repulsion do indeed come out as of equal magnitude. There is no other known reason why those opposing forces should be regarded as equal – particularly since there is no known definitive explanation for those forces *per se*[1].

An alternative approach to this issue, then, is to regard every fundamental particle as made up of a combination of left and right circularly polarized photon components which give rise to elements of electrical charge on that particle of opposite types. Every element of that charge, positive *and* negative – not just their difference – plays a part in any interaction with another particle. This is implicit in the notion that forces of attraction and repulsion are opposite but not equal.

If we now consider two particles X and Y, comprising respectively:

X: x^+ units of cyclic-photon energy circularly polarized so as to generate positive charge and x^- units of energy polarized so as to generate negative charge;

Y: y^+ units of cyclic-photon energy circularly polarized so as to generate positive charge and y^- units of energy polarized so as to generate negative charge;

and we represent the force of attraction per unit energy between unlike charges (at unit distance) by A and the force of repulsion between like charges by R, we find that:

Net attractive force between X and Y = $A(x^+y^- + x^-y^+) - R(x^+y^+ + x^-y^-)$ (1)

[That is to say: unlike elements of charge are mutually attractive, like elements of charge are mutually repulsive.]

Equation 1 can be rearranged to give:

Net attractive force = $G(x^+ + x^-)(y^+ + y^-) - E(x^+ - x^-)(y^+ - y^-)$ (2)

where $G = ½(A – R)$ and $E = ½(A + R)$

In other words, simple forces of attraction and repulsion between two particles made up of a combination of 'like charge' and 'unlike charge' elements may be interpreted as a combination of:

(a) an effect which is always attractive, proportional to the product of the masses of the two particles (since mass is itself proportional to total energy content);

and

(b) an effect which is proportional to the product of the 'net charge' on each of the two particles, repulsive if 'net charges' are of like type, attractive if they are of opposite type. This effect reduces to zero if either particle carries zero 'net charge'.

This is the interpretation which is conventionally applied to experimental results – an interpretation shown by this analysis to involve a possibly spurious addition to the other fundamental forces of nature.

4. Cosmic fine structure and dynamics

The novel view of gravitation outlined above posits a universe which is permeated by the residual electromagnetic field effects emanating from every particle of matter. In simple terms this may be seen as a 2-element scalar field at every point, comprised of a level of aggregated positive charge potential and a level of aggregated negative charge potential.

On a macroscopic scale this may be simplified further by virtue of the fact that imbalances of negative and positive potentials are relatively localised, reducing to an equal balance of negative and positive potential on the larger scale. This means that on such a scale the electrical potential at any point may be represented by just one scalar value, the magnitude of aggregated equal measures of positive and negative potential at that point.

This is in effect equivalent to the electrical potential generated at some point in space by a particle (or body) X, as referred to in equations (1) and (2) above, where that particle/body carries zero net charge , i.e. $x^+ = x^-$. In equation (2) this reduces the latter term to zero, leaving only the former term in G, an attractive effect which is proportional to the product of the masses of the two objects – or, in this case, proportional to the mass of any object at a given point in that field.

This is, by definition, the phenomenon conventionally referred to as the scalar field of gravitational potential. A single point in that field cannot of course by itself cause acceleration in any direction, however the gradient of that field at any point does give a measure of the accelerating potential at that point, both magnitude and direction. This is the vector gravitational field.

In general relativity space (or, more comprehensively, spacetime) is regarded as being curved by the presence of massive bodies and the gravitational field is viewed as a manifestation of that curvature. The formulation given above concurs totally with that view in mathematical terms: the scalar potential field as described above may be seen as a 'contour map' of space in which objects will literally gravitate towards the highest points, numerically speaking. To see satellite bodies 'falling' into 'dents' in the fabric of space caused by larger bodies, one has only to reverse the sign of those point values in the scalar field – as reflected in the generally-applied negation of the gradient of any scalar potential field.

5. Space, time and spacetime

General relativity is defined in terms of spacetime, a four-dimensional continuum in which time appears effectively on the same terms as the three spatial dimensions. In that context time is regarded as, in effect, a pseudo-spatial dimension, orthogonal to the three true spatial dimensions. One significant distinction, however, is that time is cast in mathematical terms as 'imaginary', *i.e.* time components are multiplied by a factor i, the square root of negative one.

If, as proposed here and elsewhere, particles of matter are indeed formed from time-varying electromagnetic field effects – cyclic photons – then time can be seen very clearly as a process rather than a dimension. That process is the continual flow of energy that both forms those particles and passes time-based effects between them (hence the application of the factor c to all time elements in relativistic calculations – time literally travels at the speed of light). As shown by Blackwell (2011), this perspective on time and matter explains, and provides full mathematical derivations of, all experimentally verified findings of special relativity.

[In passing, it also explains the imaginary factor i in the conventional view. This appears to relate to the 'inside-out' nature of that view: rather than objects moving through time in a similar sense to their passage through space, time is shown in the energy-flow model to be moving through those objects in the form of their formative energy flows.]

The rationalisation for gravitational effects as presented here is based on a complex interaction which may be reduced for most practical purposes to a scalar field, as shown in Section 4. Previous attempts to explain gravitation in terms of a scalar field (though not as described above), including notably an early proposal by Einstein himself, have been rejected as they cannot be made to conform to principles of Lorentz covariance. Indeed Einstein dropped his own proposal for that reason, Lorentz covariance being a fundamental tenet of Einsteinian relativity (Norton, 1992).

In essence, Lorentz covariance requires that a scalar quantity is invariant under the Lorentz transformation. That transformation, as applied in relativity theory, is based on a premise that all inertial reference frames – states of constant-velocity motion unaffected by gravitation – are equivalent. This means that such a transformation is a symmetric rotation in spacetime, a change in 'direction' in that four-dimensional continuum corresponding to a change in spatial velocity.

It is demonstrated by Blackwell (2011) that the fuller representation of the Lorentz transformation as derived from the cyclic-photon description of matter is not in fact symmetric and that frame equivalence is not a necessary condition for explanation of all experimental findings. The appearance of frame equivalence is shown to be a subjective impression due to states of motion relative to a unique reference frame that corresponds in a real sense to a state of absolute rest. It is proposed that this objective rest-frame is likely to be also the rest-frame of the cosmic microwave background radiation (CMBR).

The perceived requirement for Lorentz invariance of a scalar gravitational field is thus not only superfluous from this perspective, it is in fact contradictory[2]. Whilst the Lorentz transformation can be shown, in this formulation as in the conventional view, to conserve certain measures which combine space and time (with added significance from this new perspective), instantaneous measures of purely spatial characteristics will necessarily vary according to states of motion. The scalar gravitational field, whilst varying dynamically with time, is such a measure.

It follows that the scalar gravitational field as derived in Section 3 and described in Section 4 fully satisfies the requirements defined by the Lorentz transformation as well as fully explaining the phenomenon referred to as 'gravitation'.

6. Limitations of the conventional view

The curved-spacetime view of gravitation has proved highly successful in modelling a variety of situations. However as a meaningful description of what is actually going on it is limited on two closely linked counts:

(a) Whilst superficially appealing, the concept of an object following the contours of a shaped surface is not directly transferable to that object moving through the medium of a multidimensional continuum;

(b) The fact that an object follows a path that is in some way defined by the medium through which it is travelling indicates some form of interaction between the two, in a way that is not applicable to an object moving across a surface; the nature of that interaction, and the mechanism behind it, have yet to be defined.

The cyclic-photon view of matter, and the concomitant view of the nature of gravitational attraction, fully address both of these issues. Space has an electromagnetic 'texture' – simplified to the scalar field of gravitational potential in Section 4 – and that electromagnetic texture interacts with the electromagnetic composition of matter itself to give characteristic effects of gravitation as extensively documented.

[The details of that process are beyond the scope of this paper; however the feasibility and likelihood of such interactions between such complementary constructs are fully consistent both with the content of Sections 2-5 above and with our experience of material reality.]

7. Free fall, negative energy, escape velocity

If an object is unconstrained in proximity to a massive body, then it will accelerate towards that body (from the perspective of a static observer on that massive body). If that object was initially at rest, having only its own formative rest energy, then it would appear that it has somehow gained energy purely by virtue of being in a gravitational field, since after a period in that field it now has additional energy of motion – kinetic energy.

This process of *free fall* is rationalised in general relativity as the object following the geodesics of spacetime curved by the presence of the massive body. For a fuller explanation of what is actually going on, various other considerations need to be taken into account.

First, bringing the object to rest by transferring its kinetic energy to another body or system apparently leaves the object with just its rest energy, as in its initial state. But this is clearly not the case, as can be seen by attempting to return it to that initial state, in its original position. Work has to be done – energy must be input into the object – to regain the 'potential energy' that it has lost in moving to a position nearer to the massive body.

This leads directly to the issue of *escape velocity*, that velocity that must initially be imparted to a static object within a gravitational field to enable it to escape totally from that field. In practice, of course, the object's speed asymptotically approaches zero as that object's distance from the massive body approaches infinity. In other words:

$$E_G + E_K = E_R$$

where: E_G = energy of an object at rest at some point in a gravitational field

E_K = kinetic energy of that object at escape velocity at that same point

E_R = rest energy of that object free from the gravitational field

From this it is clear that the rest energy of an object in a gravitational field is less than its full formative rest energy. This is in accordance with the well-established premise that an object in a gravitational field experiences some sort of *negative* potential energy as compared to that same object free of such a field. The question then arises: what might this 'negative energy' be and how might it occur?

[A possible alternative hypothesis, that the object somehow draws energy from the attracting mass through its gravitational field and returns that energy on leaving the field, fails under simple further consideration. Under that scenario, two mutually attracting bodies of equal mass would each draw identical amounts of energy from the other. So neither would experience any net increase in energy – but both would gain kinetic energy.

Unless one entertains some notion of energy drawn from the quantum vacuum field (which is, at best, difficult to relate to the gravitational effect of a specific massive body) that gain in kinetic energy is necessarily at the expense of the formative structural energy of the object being attracted and experiencing such a gain.]

The cyclic-photon model of matter provides a comprehensive explanation of how an electromagnetic gravitational field supplements the electromagnetic structural energy of an elementary particle, at the same time inducing in that structure a tendency to migrate in the direction of increasing field strength. The particle thus maintains its structural integrity whilst giving up some of its formative energy as energy of motion in the direction defined by the gradient of the gravitational field.

This same model likewise explains how that particle, if given an impetus in the opposite direction, absorbs kinetic energy steadily into its formative structure as the reducing gravitational field gives progressively less support to that structure. Thus escape velocity may be seen as providing the energy necessary to reinstate independent structural integrity in the absence of support from the gravitational field. This process is, of course, aided by the effect of the field in tending to accelerate the particle into that field – manifesting as a deceleration in the outward direction.

[Note: the comprehensive explanation referred to above requires greater detail of the mechanisms of those energy transfers. That detail is beyond the scope of this paper.]

The fact that the inherent structural energy of an object at rest in a gravitational field is reduced in comparison to that same object at rest free of such a field means, of course, that the rest mass of an object is likewise reduced in such a field. This gravitational reduction in rest mass was proposed by Einstein as a real possibility in the formative stages of development of his theory of general relativity; it is also a feature of a theory proposed by Nordström around the same time, extending special relativity to include gravitational effects (Norton, 1992). Such a reduction will be masked in certain respects by the enhancement of that formative energy by the gravitational field and in other ways by gravitational time dilation. The latter will, for example, reduce the rate of acceleration of an affected object in response to any applied force by the inverse square of the time dilation factor, giving the impression that its mass is greater than it actually is.

8. The Equivalence Principle

The principles of general relativity are largely derived from Einstein's intuitive step in proposing that effects of being immersed in a gravitational field are indistinguishable from effects of undergoing a state of acceleration of comparable intensity. This leads naturally from the flat playing-field of gravity-free inertial motion to the contoured arena of motion in a gravitational field.

This *Equivalence Principle* also leads to a number of other conclusions with regard to conditions within a gravitational field: slowing down of time (which is also responsible for *gravitational red shift*); slowing down of the passage of light; curvature of the path of light passing close to a massive body. These inferences, shown by experiment to hold to a significant degree of accuracy, follow directly from observations regarding experience of such phenomena from an accelerated frame of reference (*i.e.* state of motion).

None of these phenomena has yet been explained, other than by reference to curvature of spacetime – which, as observed above, itself has yet to be explained both as to what this means in structural terms and as to the mechanism responsible for such curvature in the presence of gravitating mass.

Sections 2-6, above, detail residual electromagnetic effects emanating from material particles to give an electromagnetic texture to the whole of the universe; that texture in turn influences the motion of those electromagnetically formed particles. That texture can also be shown to account for those other observed consequences of the equivalence principle.

Maxwell's equations defining c, the speed of light *in vacuo*, arrive at that value in the absence of any background electromagnetic field effects. Non-linear time-varying field effects[3] superimposed on a photon of light will inevitably influence its waveform in some way; the retarding effects on the passage of light through matter, from rather denser versions of those same fields around the electromagnetically formed particles of that matter, indicate that gravitational reduction in the speed of light is a likely outcome.

Those same time-varying fields will also necessarily introduce an asymmetry into the wave-form of light passing a massive body, translating into a degree of curvature towards that body. This effect on a linear photon is very similar to the 'gravitational attraction' on the cyclic photon structure of a material particle as described in the previous section. [An alternative interpretation of the same effect is to view it as a differential in the degree of retardation of light as one moves outward radially from the gravitating mass.]

Finally, it has previously been shown (Blackwell, 2011) that reduction in effective rate of formative energy-flow around a particle leads to a reduced rate of passage of time for that particle exactly in accordance with both conventional theory and experimental evidence. In a situation where so-called gravitational field effects lead to reduction in the speed of light, for reasons as given above, it follows that the photons that form particles of matter will likewise cycle around those particles at a reduced speed for the same reasons – again leading to a reduced rate of passage of time for those particles. This is gravitational time dilation.

9. Conclusion

Research from a wide variety of sources lends strong support to the hypothesis that elementary particles of matter are formed from those time-varying electromagnetic field phenomena generally referred to as photons, configured into closed-loop form. The electromagnetic potential from such fields is shown by the Aharonov-Bohm effect to be unimpeded by material boundaries and hence effectively unlimited in its extent.

It has been demonstrated here that the electromagnetic potential resulting from the totality of matter across the universe, aggregated according to the strength of every contributory element at each point in space, provides a complete and coherent explanation for the effect known as gravitation. This explanation offers a rationale for the concept of curved spacetime as well as defining the mechanisms underlying effects intuited by Einstein in his equivalence principle and found to agree closely with experiment.

This rationale supports all principles of special and general relativity, with the exception of the unproven hypothesis of frame equivalence. The existence of a preferred reference frame, as identified here, leads to an asymmetry in the Lorentz transformation, conventionally regarded as a symmetric rotation in spacetime. That asymmetry relaxes the requirement for a scalar field to remain invariant under the Lorentz transformation.

It is hoped that this new perspective may provide a way forward in resolving formerly intractable issues relating to nonrenormalizable infinities in high energy quantum states, such as at the centre of a black hole, as well as opening up new avenues for investigation in various areas of fundamental research.

Notes

1. A fuller treatment of this subject, detailing likely mechanisms behind these effects, makes this difference between attractive and repulsive forces even more explicit. Such a treatment is beyond the scope of this paper; however conventional identification of *virtual photons* as carriers of those forces fits well with that treatment, as also with the summary presented here.
2. Such an implicit contradiction is certainly sufficient to introduce persistent spurious infinities in limiting situations.
3. Whilst the gross macroscopic effect of the electromagnetic emanations from matter may be interpreted as 'electric charge', and from that as point elements in a scalar field, it should be noted that this effect actually arises from time-varying electromagnetic fields. It should also be noted that those field effects, being non-linear, cannot be likened to two linear photons crossing one another.

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