The Cosmic Microwave Background & The Unification of Physics

A Synopsis
Part 1 of 2

This is essentially the paper that was first submitted to
Physical Review D (Particles, Fields, Gravitation, and Cosmology)
It was found not appropriate for the journal

The problem that occupied him has stumped physicists from Albert Einstein to Stephen Hawking: How to join together the profound yet disparate insights of general relativity and quantum theory. But Sittampalam's doodling, apparently, drew connections that the rest had missed.

"I found myself getting really angry," one cosmologist said after reading [Sittampalam's] paper. "It must have hit some real insecurity."

– *Discover*, April 2002, pp 66-71

Dear Editor-in-Chief,

The Cosmic Microwave Background and the Unification of Physics

I am submitting herewith a breakthrough paper for your kind consideration for publication in your esteemed journal.

The paper is based on hard and well-verified facts of observation. Not surprisingly, the final theory of our observable world is indeed an extremely simple one. In a nutshell: The atom is the condensed form of matter (mass-energy) and electromagnetic radiation, the evaporated form; and all of fundamental physics – from the atomic to the cosmic – becomes classical mechanical in scope and high-school stuff in comprehension. (It is as envisioned by Professor Stephen Hawking in the concluding lines of his famous book, *A Brief History of Time*: "However, if we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists…")

In the overwhelming new light since the time of Einstein, we now have, for instance, an embarrassingly simple and classical mechanical explanation for the Michelson-Morley Experiment. What need have we any more for the abstract? Please, therefore, be good enough to read the entire script yourself first, since this is science history in the making! Also, should any of your learned reviewers rule negative, do kindly request of them just *one* down-to-earth reason for their decision, since philosophical arguments in the abstract will never find resolution in physics.

In particular, they may comment on section 5 of the paper, “The Vacuum Energy Field and the Contraction of Moving Bodies,” and the derivation therein of the Lorentz-FitzGerald Contraction Factor – now for the very first time from first principles. This section will prove pivotal to physics today since it takes us from the Einsteinian world of make believe and back into the Newtonian world of our everyday experience. (It is more likely that reviewers here will find solutions even to their own research problems as a radical reawakening takes place across the board when our old notion of gravity – that this most ubiquitous force in nature springs from within matter with some mystical pulling or space-warping power – gets corrected.)

To build that solid and irrevocable foundation for this singular and all-embracing theory for all time, I have, in section 2, drawn attention to, and elaborated on, the cosmic microwave background radiation. The flux, E_o, of this all-important isotropic energy directly relates to the force field of the classical vacuum and its confining or gravitational effect on matter. If you will pardon my assertion here – the sooner we realize and accept this fundamental fact of the vacuum, the sooner will basic physics research be out of the woods.

The book that I authored is referenced in the paper as Sittampalam 1999. I shall rush to you, by courier, the number of copies that may be required in the review of the paper.
I await your kind response.
Thank you and best regards.
Yours sincerely,
Eugene Sittampalam

Simon Eugene Sittampalam
PO Box 134, 645 Beach Road
Jaffna, Sri Lanka
Telephone: +9421 222 6851
+9411 259 5259
E-mail: eugenesittampalam@gmail.com
Website: www.sittampalam.net

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THE COSMIC MICROWAVE BACKGROUND & THE UNIFICATION OF PHYSICS

The Cosmic Microwave Background
&
The Unification of Physics

Eugene Sittampalam

Abstract:

The root cause for many of the mysteries, controversies, and travails in fundamental physics is the haze that continues today in our concept of the basic photon. The description of the photon, an entity that cannot be any more basic to physics, still languishes in a world of ("wave-particle") ambiguity and paradox. Fortunately, the radiation field of the Cosmic Microwave Background now provides us with a convenient stage on which to model the true and final concept of the photon for all time. The words "true and final" are not used loosely at all here – since the concept readily leads to the total unification of physics and to the long-sought "Theory of Everything" (Sittampalam 1999). Propounded here in a short paper is this foundation for physics. On it has been built the singular and all-embracing theory that explains the working of our entire universe of observation – from the atomic to the cosmic – in the space and time of our everyday experience. We shall discover here a physics that thrives solely on causal chains, and a physics that reinstates the primacy of classical mechanics. One should not therefore be too surprised to also find that there is but one *and only one* fundamental particle of analysis for both mass and energy – the "per-cycle" quantum of the photon – and that this mass-energy custodian alone, moreover, wields that fundamental and singular clout in nature, be it gravitational, electromagnetic or nuclear.

1. INTRODUCTION

The night sky is not dark after all. NASA's Cosmic Background Explorer (COBE) satellite launched into space in 1989 has testified overwhelmingly to the fact (Peebles 1993; Turner 1993). The sky is indeed suffused with a remarkably even glow of electromagnetic radiation throughout – day or night. The COBE satellite tells us, in other words, that isolated space is submerged in a long-range quantum energy field that is also highly isotropic and homogenized. As also confirmed by the COBE instruments, this radiation is in the microwave range and is now accordingly called the Cosmic Microwave Background, or the CMB. (If we were creatures with microwave vision – we would know no night!)

Here, in this eternal cosmic light, is seen the ultimate model for the photon with the consequences it entails for the rest of physics. We shall see the unification not only of the forces of nature but also of matter and energy in a *single* physical entity that has only been too well known to us. Though incredibly simple and straightforward, the concept, however, has remained unrealized to date.

2. THE CMB & THE PHOTON CONCEPT

Imagine a space in complete isolation such as intergalactic space... far removed from all material objects. The CMB will be isotropic and homogeneous. The speed, c, and the effective overall wavelength, say, λ_o, of the CMB (see subsection 2.1, below) will be the same in all directions with no preferred net movement of these microwave energy photons in any given direction (relative to distant objects).

Even this desolate vacuum of space being totally permeated and filled with energy, “empty space” would be a contradiction in terms in fundamental physics.

In this voidless “vacuum” field, the CMB is thus the vacuum field energy.

It also follows that a photon cannot bodily travel between two points even in the vacuum. Instead, the photon simply transmits its effect *vibrationally* through the fluid-like energy medium that is the vacuum. In principle, it is not different to the transmission of sound through a material medium. Thus, the photon has the vacuum energy field as its medium of propagation. (As we shall see in section 3 below, the vacuum is indeed a fluid-like medium of energy where *every single frequency* of the electromagnetic spectrum is vibrantly present in all directions. It is *intensity* of energy that determines whether that energy is detectable or not to our material instruments. For instance, in isolated space, only the intensity in the microwave range remains sufficient for detection. However, when light comes to us, say, from a star, the corresponding frequencies in the vacuum field are intensified along the line to cause the effect for their detection.)

The most important point of note here is that the photon has a *vibrational*, or a to-and-fro, motion at speed c – and *not* a motion that is solely unidirectional between source and observer.

And this simple insight now into the quantum world leads readily to the derivation of, perhaps, the most famous equation in science, $E = mc^2$, and more!

2.1. The flux of cosmic energy

Let us start our detailed investigation here with the speed-c radiation that we detect today as coming from deep space all around. Let the intensity of this cosmic energy be, say, E_o per unit area per unit time. This minimum background flux of E_o may be assumed a universal constant from the sheer isotropy that is measured of it. However, as measurements also show, E_o is not confined to the single wavelength of λ_o (introduced above). In fact, E_o spans a wide band of wavelengths. (See, for instance, Peebles 1993, pages 131-134, where the paragraph starts: "At wavelengths in the range of millimeters to centimeters, the extraterrestrial electromagnetic radiation background is dominated by an isotropic component, the cosmic background radiation, or CBR. The isotropy suggests the CBR is a sea of radiation that uniformly fills space. This would mean an observer in any other galaxy would see the same intensity of radiation, equally bright in all directions, consistent with the cosmological principle." Note: The CBR is referred to as the CMB in this paper.)

Nevertheless, the *transferable physical effect* of E_o will simply be its momentum, say, P_o, which (as per subsection 2.2, below) will be given by,

$$P_o = E_o/c \tag{2.1}$$

Hence, in our analyses here, the wavelength λ_o would simply and conveniently represent the *equivalent* monochromatic photons having the same energy of E_o per unit area per unit time and thereby also the same momentum of P_o per unit area per unit time given by Eq. (2.1).

It further follows that, if, say, e is the energy of *each* of these λ_o-wavelength photons, then the number density (or particle density) of these analytical photons will be E_o/e per unit area per unit time.

Hence, in analyses, the cosmic background energy may be equivalently considered as a constant stream of *monochromatic* photons with the following characteristics:

(a) Wavelength of photon = λ_o

(b) Energy of photon = e

(c) Energy intensity of photons = E_o per unit area per unit time

(d) Number density of photons = E_o/e per unit area per unit time

Now, as per classical mechanical theory: (i) pressure is force per unit area and (ii) force is momentum change per unit time. Combining (i) and (ii), we will have: pressure is momentum change per unit area per unit time. Hence, if P_o is the momentum of E_o, and A_o is the pressure of this cosmic flux, then,

$$A_o = 2P_o \tag{2.2}$$

since the (vectorial) momentum change that causes pressure on a surface is $2P_o$ in magnitude, that is, P_o on impact plus another P_o on recoil from surface.

Hence, from Eqs. (2.1) and (2.2), the *minimum detectable pressure*, A_o, of the classical vacuum of space will be given by,

$$\boxed{A_o = 2E_o/c \tag{2.3}}$$

2.2. The equivalence of mass and energy

A reflector of the CMB energy would feel a constant ticking of the photons as if they were some form of matter particles striking it at space intervals of λ_o, or time intervals of $t_o = \lambda_o/c$. And here's another important point of note. Though each seeming particle bombarding the reflector comes in at velocity c, the selfsame particle's net displacement over the period t_o would remain zero since no net movement of energy takes place in the given space (under steady-state conditions). In other words, in principle, each particle would have a to-and-fro motion within a length of $\lambda_o/2$ with zero net displacement over t_o.

The photon is eternal. It is absolutely indefatigable. It may take billions of years for (the effect of) the CMB photon particle to reach us from the far cosmos; but once it's arrived, its energy would be found to be no different to that of a photon particle that comes a-ticking at the same frequency from a local source.

Analytically, therefore, the CMB photons – in fact, photons, in general – may be considered as perfectly elastic particles with mass, energy, and volume. Perfectly elastic particles, as we know, conserve energy (and mass) individually and absolutely. They do not give out or take on energy in any interactions. The particle energy can only get transformed between kinetic and potential within the particle; the energy thus remaining intrinsic and nontransferable. When two such identical particles collide, say, head-on, the velocity of each particle drops from c to zero, momentarily, and reverts to the same magnitude of c in the opposite direction. Thus, the particle energy switches totally from kinetic to potential and back to kinetic again. And it is momentum – *and momentum alone* – that gets transferred between particles in any and all interactions.

The CMB photon is thus a perfectly elastic particle, fully and forever resilient. Let its energy be e and mass m. (Yes, let us here be rid of any preconceptions from partial theories such as special relativity where it is argued that the photon cannot have a mass, that is, a so-called rest mass; if that's difficult, let's consider m as that theory's "inertial mass.")

Hence, the single CMB photon has energy e, mass m, velocity c, wavelength λ_o, vibrational length $\lambda_o/2$, vibrational period λ_o/c, and momentum change from a vibrational impact 2mc (that is, reckoned vectorially, a change of mc at impact plus another change of mc at recoil).

In classical mechanics,

energy = work done

= force x distance

= pressure x area x distance

= pressure x volume

Hence, for the vibrant particle of the CMB field,

energy = pressure x vibrational volume

= (force / vibrational area) x vibrational volume

= force x vibrational length

= rate of momentum change x vibrational length

That is,

$$e = [2mc / (\lambda_o/c)] \times (\lambda_o/2)$$

or,

$$e \ = \ 2mc \times (c/\lambda_o) \times (\lambda_o/2) \qquad (2.4)$$

Whence, from equation (2.4),

$$\boxed{\mathbf{e \ = \ mc^2} \qquad (2.5)}$$

Get the physical model right, and the physics of nature turns embarrassingly simple! We have the first glimpse of this fact in the above derivation of the famous equation in science (expressed here as $e = mc^2$) – for the very first time from first principles. (For derivation of the equation using Einstein's special relativity, see, for instance, Born 1965, pp. 278–280.)

As we shall also see in section 3 below, mass and energy are intrinsic not only to the photon but also to matter – the latter being just the condensed form of the former! And since c is an absolute constant (in the "rest" frame of the CMB; section 5 below), the classical concepts of mass and energy may now be merged as one by virtue of Eq. (2.5). Mass and energy, therefore, will now refer to one and the same parameter of measure in fundamental physics. Let's call it MASS-ENERGY. We may still use the terms "mass" and "energy" in our analyses as long as we know the two are not fundamentally distinct entities, like space and time.

Now, momentum is mass times velocity. Therefore, if p is the momentum of the single CMB photon, then,

$$p \ = \ mc \qquad (2.6)$$

From equations (2.5) and (2.6), we will then have,

$$\boxed{\mathbf{p \ = \ e/c} \qquad (2.7)}$$

which is another well established empirical formula in quantum physics

2.3. Planck's Law

The quantum e and wavelength λ_o correspond to the absolute minimum amount of detectable energy in the universe. That is, *nothing less may be detected by any physical means* in the desolate vacuum field or elsewhere. Now, *just for ease of reference* hereinafter, let us call this single photon particle of absolute minimum energy – THE RADIATON (pronounced: radiate-on!).

Hence, a detector in isolated space will, in effect, receive radiatons at spatial intervals of λ_o, or time intervals of $t_o = \lambda_o/c$, or frequency $f_o = 1/t_o = c/\lambda_o$. (Note that each of these radiatons is the single CMB photon of energy e.) Therefore, as observations confirm, all other photons may be considered as just integer multiples of e carried within the length of λ_o. And all these higher energy photons (generally absent for detection in isolated space) will require their own sources to originate from. (As we shall see in section 3 below, every single wavelength of energy is indeed vibrantly present even in the vacuum of isolated space, but it is intensity that determines if that energy is detectable or not, that is, to material instruments.)

Thus, from an external source, the next photon energy, which is 2e, or two radiatons, will be received by the detector only at the statistical wavelength of $\lambda_o/2$, or frequency $2f_o$. That is, in effect, from source to detector, an extra radiaton will be transported within the spatial interval of λ_o; and, *statistically*, the extra radiaton will be evenly spaced within λ_o. The next photon energy, 3e, will be similarly received at frequency $3f_o$ (or two extra radiatons evenly spaced within λ_o), and so on.

This shows the photon energy to vary linearly as its detected frequency. In other words, the photon's energy, say, E, is directly proportional to its detected frequency, say, f; or,

$$\mathbf{E = hf} \tag{2.8}$$

where h is the constant of proportionality.

This is the law of the radiation field that was first postulated by Max Planck in 1900. *It is derived here for the very first time from first principles*.

Thus, E is a simple multiple of e; f is the frequency of the e-energy particles, or radiatons, in the 'train' of length λ_o carrying the single E-energy photon; and h, the constant of proportionality, is also known as the Planck constant.

Analytically, therefore, all single photons have the same length of λ_o in the direction of radiation; the energy of the photon is represented by the number of its constituent radiatons carried within the length λ_o; and the frequency, f, and wavelength, λ, of the photon correspond to these speed-c radiatons being evenly spaced within the length of λ_o. THE RADIATON IS THUS THE "PER-CYCLE" PARTICLE OF THE PHOTON, IN GENERAL. (The transverse disturbance in the vacuum field gives the photon its wavelike nature; see Sittampalam 2003, Two-Slit Tests.)

On the other hand, wavelengths longer than λ_o registered by detectors are, in reality, pulses of (λ_o-length) photons from the source. That is, they are intermittent emissions of energy, 2e or higher, pulsed through the ambient field at the detected (pulse) frequency. The pulsed photons thus 'ride the crests' of the signal wave.

Typically, such a wave is the radio signal and is emitted by the electron as it oscillates between two orbital energy levels of the atom: The electron becomes more in energy content at the higher radial level, having been boosted to the level by the absorption of a photon; its orbital frequency being no longer synchronous with the breathing cycle of the atomic nucleus, the electron finds it unstable at this so-called excited level; as a result, the electron spontaneously drops back to its stable ground level; as the electron thus descends into an ambient of increased asymmetry (brought about by the closer proximity of the nucleus), the energy it gained gets "squeezed" out; and the cycle of quantum leap and quantum fall back repeats, conditions permitting. (Descriptions of the electron's orbital cycle and the excited state are given, respectively, in Sittampalam 1999, sections 5.06 and 5.07.)

λ_o now assumes great significance as also the "photonic length." It is the reference length on which all the photons of the electromagnetic radiation spectrum are based. Further, λ_o gives a physical meaning to Planck's constant, h, for the very first time, as we shall also see next.

3. THE CMB & THE ATOM

The central failure of classical mechanics, it is often said, is its inability to account for the structure of the atom. That is, until now.

3.1. The force field of the atom

Equation (2.8) expresses Planck's law. It simply tells us: "Photon energy equals a constant times cycles per unit time period." Transposing it, we will have: "Photon energy per cycle equals a constant per unit time period." In other words, the energy per cycle of the photon is an absolute constant. This absolute per-cycle energy quantum, or particle, is the radiaton (see subsection 2.3, above). The radiaton is thus (detectably) the most basic constituent of any photon of the electromagnetic spectrum.

Consider two single radiatons. In a head-on collision with one another, the momentum of each particle changes from mc in one direction to mc in the opposite direction. Any momentum change for an inertial body, though, takes place not instantaneously but over a finite lapse of time. The radiaton momentum will thus change from mc, through zero, and back to mc again (in the opposite direction) during a nonzero time interval. However, should any next encounter for the particular particle take place before the lapse of this period, the radiaton would be found lacking in "clout," not having regained its full momentum of mc.

The force field of such a region, that is, of very short wavelengths, will thus remain subdued. The equatorial diameter λ_n of nucleons and electrons exhibits this critical wavelength below which the radiatons continue to be vibrant only at sub-c speeds, that is, within the subatomic particle. At the surface of the subatomic particle, the radiatons just attain the wavelength λ_n with speed c at their vibrational midpoints. (Surface speed is maximum at the equator of the spin particle; the critical diameter λ_n is thus maintained at the equator as the particle expands and contracts along the polar axis over its breathing cycle; see Sittampalam 1999, section 2.06.)

Thus, within the atomic nucleus, the radiaton exerts less force as a consequence of its sub-c speed, compared to the force it would exert at the nuclear surface, that is, at speed c. (In fact, the force field attains a universal maximum at the nuclear surface; see Sittampalam 1999, sections 2.08 and 2.09.) As a result, the radiaton energy remains considerably dormant within the atomic nucleus. The energy release in a nuclear reaction is but the partial venting of such entrapped radiatons out into free space. (Note: It is purely for the purpose of theoretical analysis that the radiaton is considered here to remain a discrete entity even within the atomic nucleus. However, in reality, the atomic nucleus need not contain its energy as individual radiatons even though the speed-c energy it releases comes out detectably in that form. An analogy to this is seen in the macroscopic world: Water does not exist as discrete drops in the pipeline although it emerges as such from a leaky faucet.)

3.2. The states of mass-energy

Hence, analytically, only at the nuclear surface do the radiatons just attain speed c and can evaporate off. Ambient radiatons, on the other hand, can lose their speed c at the nuclear surface and condense into the nucleus. At steady state, these two processes become balanced. (Note: It is the spin of the subatomic particle that knocks the ambient radiatons and entraps them inside in net over a half cycle; see Sittampalam 2003, The Spin.)

In this perspective, it is plainly seen that THE PHOTON IS BUT THE EVAPORATED STATE OF MATTER, OR MASS-ENERGY, AND NUCLEONS AND ELECTRONS THE CONDENSED FORM. Further, even the vacuum being totally permeated and filled with the photons of the cosmic background, OUR UNIVERSE OF OBSERVATION IS BUT A SEAMLESS AND VOIDLESS CONTINUUM IN MASS-ENERGY. (Strictly, neutrinos contribute equally to the evaporated form. This is taken up in section 6 below. Sittampalam 1999, section 2.06, explains how a nonvanishing seminal spin of this mass-energy continuum maintains an overall balance between its evaporated and condensed phases as at triple point.)

3.3. The atom as seen by the photon

It also now becomes a simple exercise, as given in Sittampalam 1999, pages 37-43, to show (quantitatively) that the atom presents to the photon a body of diameter equal to to the wavelength only of the photon itself. That is,

$$\boxed{\mathbf{d_{atom}} = \boldsymbol{\lambda_{photon}} \qquad (3.1)}$$

In other words, in isolated space, for instance, where the wavelength of the ambient field is λ_o, the atom will have an effective diameter of λ_o. But, say, an X-ray photon of wavelength λ_x will be intercepted by the atom only at a depth corresponding to diameter λ_x of the atom.

3.4. The communion of atoms

Condensation and evaporation take place unceasingly at every (quantum) energy level of the atom. This breathing keeps the atom forever live even in its ground (or "unexcited") state. The exchange also keeps the atom in constant communion with the other atoms whether they be separated by ångströms or light years across the vacuum field. That is, each energy level of the atom would be resonant with corresponding levels of the other atoms of the continuum. Thus, any two ground-state atoms at rest in an inertial frame would still be in contact by way of their minimal exchange of radiatons across the separating void. This necessitates, for consistency when all the atoms of the inertial system are considered, the simultaneous absorption followed by the simultaneous emission of radiatons. Hence, a pair of corresponding atomic levels would always remain synchronous, in phase, and separated by an integer wavelength number along their line of centers.

Furthermore, the atomic energy level is non-rigid. That is to say, energy is emitted not from a fixed point in the atom but from a highly resilient membrane-like stratum. Consequently, any adjustment to the distance separating the (imaginary) centers of two atoms would result only in full wavelength shifts between their corresponding energy levels.

An excited atomic level would emit detectable energy, the smallest quantum of which is the single photon characteristic of that level. A given photon of detection may thus originate only from a specific atomic energy level when excited; and this photon may now be absorbed only at a downstream atomic level that is resonant with the incoming energy. But, with both their atomic centers at rest in an inertial frame, these two levels will already be synchronous, in phase, and separated by integer wavelengths at the unexcited state itself. Thus, their ever-vibrant relationship gets only enhanced in the excited state. This state of communion is independent of the frame velocity and the orientation of the line of energy transfer with respect to that velocity. And with these renewed insights into the quantum world, the famous Michelson-Morley Experiment of 1887 now finds a simple and straightforward explanation. It is the seemingly strange findings of this very experiment that set the stage for Einstein's theories. (A revisit to relativity in the renewed quantum light is made in section 5 below.)

3.5. The universal force and pressure fields

Hydrogen is the basic atom and chemical element. Its nucleus is the single nucleon. Considering just the basic atom in isolated space, it can now be easily shown (Sittampalam 1999, chapter 2) that:

(a) The absolute maximum force, F_{max}, in the universe occurs at the nuclear surface, and is given by,

$$\mathbf{F_{max} = mc^2/\lambda_n} \tag{3.2}$$

where m is the radiaton mass and λ_n is the equatorial diameter of the nucleon.

(b) The absolute minimum force, F_{min}, in the universe occurs in the vacuum of space, and is given by,

$$\mathbf{F_{min} = 2mc^2/\lambda_o} \tag{3.3}$$

where λ_o is the CMB wavelength.

(c) Outside as well as inside the nucleus, the force field drops from F_{max} to F_{min}. That is, with decreasing atomic radius, the force field of the atom would increase from the low outside ambient value of F_{min} to peak at the nuclear surface at F_{max} and then drop back to F_{min} at the nuclear center.

(d) The F_{min} within the nucleus occurs inside a nonvanishing central sphere of diameter d_o given by,

$$\mathbf{d_o = 2\lambda_n^2/\lambda_o} \qquad (3.4)$$

(e) The Planck constant, h, is fundamentally a pure wave number, given by,

$$\mathbf{h = \lambda_o/\lambda_n} \qquad (3.5)$$

In other words, h is an integer, a number that simply tells us "how many times λ_n goes into λ_o." THE PHYSICAL SIGNIFICANCE OF h IS THUS REALIZED FOR THE VERY FIRST TIME IN PHYSICS.

[Note: λ_o is in the microwave range, or of the order of 10^{-3} m; λ_n is in the gamma-ray range, or of the order of 10^{-15} m; hence h (= λ_o/λ_n) will be of the order of $10^{-3}/10^{-15}$, or 10^{12}.]

From Eqs. (3.2), (3.3), and (3.5), we will then have,

$$\mathbf{F_{max}/F_{min} = h/2} \qquad (3.6)$$

(f) The pressure on the nuclear surface is an absolute constant. It is *not*, though, the absolute maximum. The absolute maximum pressure, A_{max}, in the universe occurs in the interior of the nucleon, on the central sphere of diameter d_o given by Eq. (3.4). The absolute minimum pressure, A_{min}, in the universe occurs in the vacuum of space, where $A_{min} = A_o$ is given by equation (2.3). The ratio of the maximum pressure to minimum pressure is given by,

$$\mathbf{A_{max}/A_{min} = h^4/4} \qquad (3.7)$$

where h is given by Eq. (3.5).

Again, the nucleus of the basic atom is the single nucleon. The force field of the basic atom, as we saw above, is a universal maximum at its nuclear surface and drops therefrom to a universal minimum toward the center (as well as toward the periphery of the isolated atom). In a multi-nucleonic atom, too, the force field remains basically the same. In such a heavy atom, the nucleus will have a grain-like topography seemingly of partially submerged spheres of single nucleons (reminiscent of a rubber balloon filled with marbles instead of air). To the outside field, the nucleus will thus present, *at every point on its surface*, the sphere of the single nucleon. The force field of the heavy atomic nucleus, too, will thereby be the same universal peak at the surface and tend toward the same universal trough at the center of each surface nucleon (as well as at the atom's outskirts). Well within the heavy and recess-free nucleus (of condensed mass-energy) the force field remains lower than at the surface, with the universal minimum field occurring at the centers of the nucleonic eddies therein. (See Sittampalam 1999, sections 2.13 and 6.17 for a fuller discussion.)

The ramifications of Eqs. (3.6) and (3.7) are indeed astronomical, literally. The absolute maximum force and the absolute maximum pressure in the universe, which are associated with the atom, are both finite. That is, *they do not tend to infinity*. Gravitational collapse of matter, therefore, is an absolute nonevent, and the speculated black hole an absolute nonentity, in our physical universe[1]. The ever increasing "evidence for black holes" has indeed a much simpler explanation in the new light, as we shall see in section 8 below.

[1]The pressure of the vacuum energy field on the atom is naturally transmitted to the core of the atom. Since the pressure on the surface of the atomic nucleus is an absolute constant, the nucleus simply grows in size (nucleon number) should this nuclear surface pressure tend to exceed. (Pressure is an inverse function of radius; therefore, under increasing applied pressure, a given pressure value within the body can only be met at increasing radius.) Thus, under increasing outside radiation pressure, net mass-energy condenses into the nucleus and constancy of pressure on the nuclear surface gets maintained by radial extension of the nucleus – without matter collapse. The maximum pressure, too, that is, nearer the nucleonic centers, is thereby unaffected. Under any excessive pressure increase, the nucleus simply grows excessively, or buckles and fragments into smaller nuclei when the pressure becomes no longer uniform all around at that higher radius. (The neutron star is thus essentially a gigantic atomic nucleus born, and nestling, under such extreme growth in ambient pressure conditions. Fluctuations in the local pressure field of the nucleus are the basic cause for nuclear decay, the only type of "collapse" there is for matter; a large fluctuation causing a heavy nucleus even to split or bifurcate. (See Sittampalam 1999, chapter 6; and Sittampalam 2003, Nuclear Reactions.)

Further, it is also evident from equations (3.6) and (3.7) that the absolute minimum force and the absolute minimum pressure in the universe, too, are finite. That is, they do not tend to zero even in the vacuum of deep space where they both occur. Thus, neither the concept of infinity nor the concept of zero from the mathematical domain has any absolute hold in the physical arena. Fundamental physics may now be rid also of absolute zeros and infinities, point particles, and singularities which make even mathematics break down at their thresholds.

Let us consider next the concept of gravity in the light of the CMB, which final and quantum insight will pave the way to the unification of physics across its entire realm.

4. THE CMB & QUANTUM GRAVITY

Many a unification theory for the fundamental forces of nature has been proposed in the past; but gravity, at least, remains extremely difficult to reconcile with the other forces (Weinberg 1993). The root cause for this state of affairs is attributable to none other than to our continuing preconception – that gravity is intrinsic to matter. In the light of new and improved observations, especially of the past decade, a review of that ancient wisdom seems only long overdue. What is presented here is that review of gravity – but *strictly* within a framework of well-established laws of classical physics.

4.1. The most ubiquitous force in nature

An atom (or molecule) is at rest in isolated space. A photon strikes the atom. There is a spontaneous exchange of momentum. And the whole atom – including the massive nucleus – moves. Momentum transfer from even a radiowave or a microwave photon thus takes place from atomic level to atomic level – to move also the mighty nucleus.

Photons pack momentum. Though the photon does not penetrate to all levels of the atom, its momentum, nonetheless, does – and goes even to the cores of stars and planets without exception.

Earth's magnetosphere, for instance, extends to several Earth diameters above us (Lyon 2000). The solar wind particles get deflected by this great bubble, which action gives it its comet-like shape with a tail extending to several million kilometers away from the Sun. The magnetosphere thus deflects an enormous amount of momentum every single second. What about all that momentum transferred down to the Earth core as a result? Yes, that's (quantum) anti-gravity; see Sittampalam 1999, section 1.03, and Sittampalam 2003, Anti-Gravity. Here, however, we shall draw our attention primarily to the equally ill-understood phenomenon that is – Gravity.

Once again, the atom is at rest in isolated space. This time around, two identical photons strike the atom simultaneously and from diametrically opposite directions. The atom absorbs the energies at a specific level and reemits the energies from the same level. The two photon momenta being always equal and opposite, the atom gains no net momentum. The atom is unchanged, and continues in its state of rest. The photons, too, are unchanged in energy, having been (elastically) turned around by a non-moving object.

Next, two atoms are at rest in the given space. A distance separates them. Two opposing CMB photons approach the atoms along the line of atomic centers. Each atom, shielded by the other, is struck by only one photon. The photons are reemitted. Each atom is rendered a momentum. And the two bodies move – or gravitate – toward each other.

And this, basically, is gravity, or quantum gravity since the effect is caused by photons, or energy quanta.

The motion causes the bodies to contract (see section 5, below). The compaction or squeeze causes the bodies to eject net energy in the wake and transverse to motion – the "gravitational radiation" in the context here. Each emitted photon is intrinsically lower in energy and, therefore, in frequency (Doppler shift accounted for). This is due simply to the fact that the photon emerges from a level that is itself lower (proportionately squeezed out) in energy compared to the level at zero velocity (see also Sittampalam 2003, Gravity and Relativity).

It may now seem hard to accept the simple fact that shielding of the long-range cosmic radiation pushes bodies together to cause the gravitational effect[2]. Our current concept of the phenomenon, on the other hand, seems virtually unquestioned; a concept that some exotic energy, constantly emanating from the bodies themselves with some mystical tendrils to grab and pull (or even warp and bend space and time) produces the effect. We have been weaned on the latter from early years and, therefore, easy to accept without question. But science stands still without inquiry.

[2]The initial apprehension here is understandable, but the effective overall diameter of the cosmic body for radiation shielding is generally several times that of the opaque sphere that we see. (Earth's magnetosphere – several times Earth's diameter – and the effect it has on the solar wind highlight this universal fact.) Moreover, the long-range radiation includes the sea of neutrinos now known to pervade space, which copious energy particles are also lately detected to have a gravitational effect (Dickson and Schutz 1995). In other words, the absolute pressure of the vacuum on material bodies is very much in underestimation today. When redressed, as done here, the long-sought and simple theory of quantum gravity becomes also an unquestionable reality. Physics should thus see a radical reawakening across the board when our old notion of gravity – that this most ubiquitous force in nature springs from within matter with some mystical pulling or space-warping power – gets corrected. We can now totally do away with our search for the constructs of the old theory such as black holes, dark matter, and big-bang relics. (Complacency could only see research cost skyrocket further without an end in sight.)

However, the utter simplicity of the final concept, once known to the larger science community, should make it even harder to ignore for the true advancement of science.

4.2. The breathing of celestial bodies

A body, X, in isolated space absorbs the long-range radiation and emits the energy out. It is a spontaneous exchange of the body with the cosmic quantum field. And the frequency of exchange corresponds to the body's natural breathing or vibrational cycle in that environment.

A body, Y, of greater mass (more nucleons) would thus exchange a larger amount of energy with the outside field. The flux of the outside field being the same, however, it would take a longer time for the greater mass of Y to inhale and exhale. That is, larger the body, larger is its period of natural vibration.

Thus, for instance, the hydrogen atom (1 nucleon) would have a certain vibrational period in isolated space, and the helium atom (4 nucleons) a larger period. (This period of He, though, is not necessarily four times that of H, since other factors, such as exact mass and shape of nucleons, determine the breathing amount.)

The above insight is simply to highlight the fact that the cosmic field energy intercepted and reemitted by, say, a celestial body is a function of its mass; and that this mass function cannot be taken to be a linear one.

4.3. Derivation of the Inverse-Square Law of Gravity

The CMB is isotropic and homogeneous in isolated space[3]. Its energy E_o and momentum P_o per unit area per unit time will thus be a constant (see also section 2.1, above). Consequently, the pressure that this radiation exerts on a totally reflecting (hypothetical) surface, too, will be a constant.

[3]Strictly, the term CMB here refers to the entire spectrum of isotropic radiation from space. Half of this energy consists of the presently ill-understood neutrinos. In the new light, the photon and the neutrino do not have much fundamental difference. Both move at speed c and both pack energy and momentum. The only difference is in their mode of propagation: The photon is essentially one-dimensional, proceeding in a straight line from its source; and the neutrino is two-dimensional, expanding radially and broadside from source equator (see section 6 below).

Again, as we saw in subsection (2.1), pressure is momentum change per unit area per unit time. Hence, the CMB pressure, A_o, on a totally reflecting surface will be $2P_o$, since, reckoned vectorially, the change of momentum per unit area per unit time is P_o on impact plus another P_o on recoil (reflection); or,

$$A_o = 2\,P_o \qquad (4.1)$$

where,

$$P_o = E_o/c \qquad (4.2)$$

In general, the amount of energy absorbed and emitted by a real body depends on its mass and other properties. In other words, it would be incorrect for us to assume that this energy exchange is a function of the body mass alone. Therefore, let us simply say that, at steady state, a given body of matter in isolation exchanges energy with the CMB field that is k times its mass m, or km, per unit time. (The factor k can be considered a constant *only* for bodies identical to this specific body, that is, of a given mass, chemical composition, form, shape, and even ambient conditions.)

Thus, the body at isolated rest would in effect exchange, radially from its mass center, an energy of km with the isotropic CMB field[4].

[4]We are deriving here an expression for the force of gravity; an expression that has only been an empirical fact until now. The particular approach of analysis chosen here is simply to bring the derived expression in a readily recognizable classical form, which is equation (4.8), a well known equation perhaps even in grade school.

Now, purely for our analysis here, let us replace this real body with a hypothetical sphere, S, that is totally reflecting to the CMB radiation. The surface area of S will be $4\pi r^2$, where r is the radius of the sphere. Further, let the energy (and momentum) exchange between S and the CMB field be the same as that between the real body and the CMB. Thus, the physical effect between body and CMB field will be the same in the two cases. (Physical effect here is simply momentum transfer, which is the same whether a body absorbs and reemits a photon or simply reflects it off at the surface.)

Since the real body absorbs and emits energy km per unit time, and body S would reflect the same amount at its surface (where the energy would come in at E_o per unit area per unit time), it follows that:

$$4\pi r^2 E_o = km \qquad (4.3)$$

Now, a body of mass m_1 would exchange energy $k_1 m_1$ and a second body of mass m_2 would exchange energy $k_2 m_2$ when each body is in (the same) isolated space on its own. (Again, it would be wrong for us to assume that $k_1 = k_2$.)

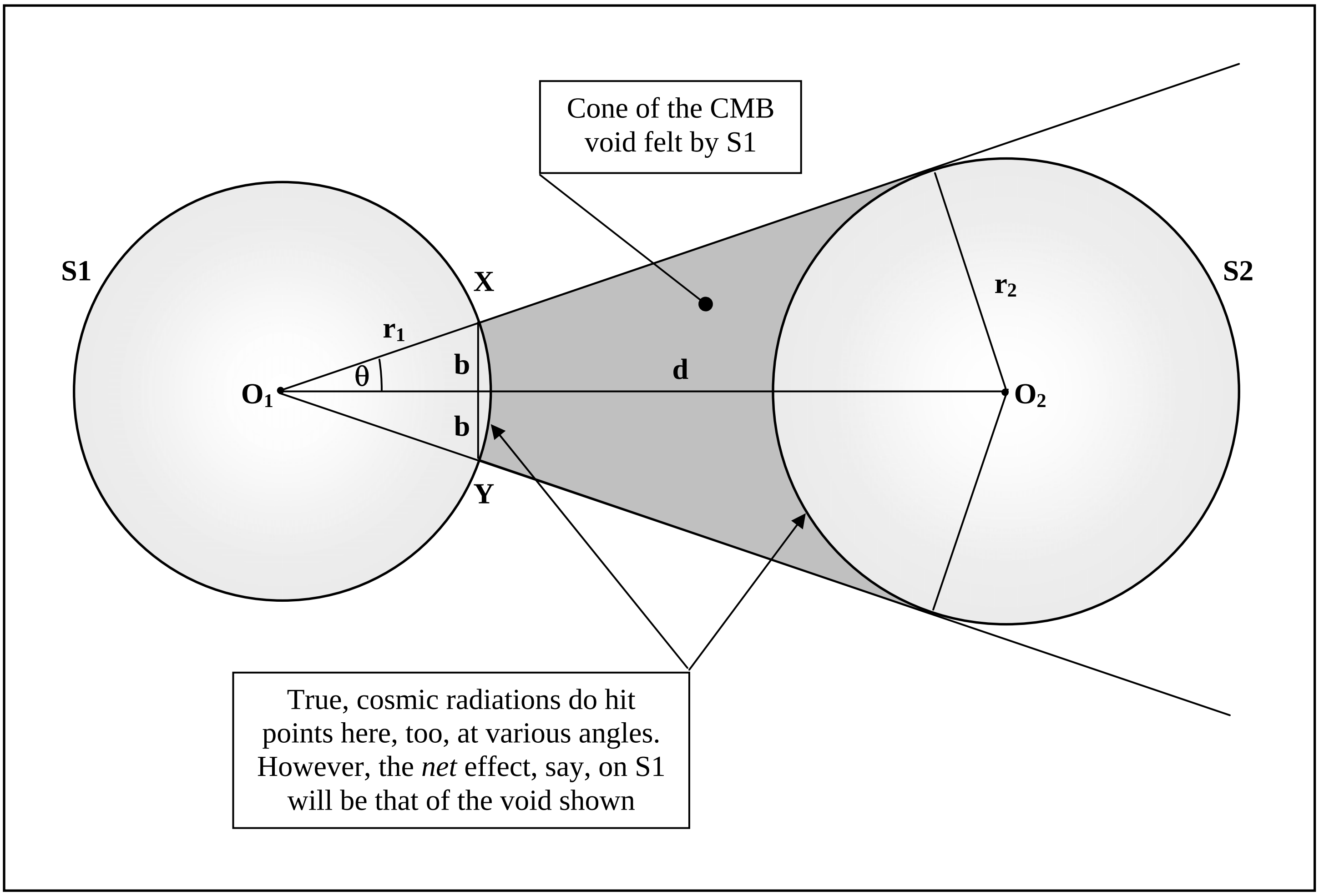

Figure 1. The CMB shielding of S1 by S2. Only the analytically equivalent gravitational spheres, S1 and S2, of the two celestial bodies are shown here.

Hence, for their corresponding analytical bodies, S1 and S2 of respective radii r_1 and r_2, it follows from equation (4.3) that:

$$4\pi r_1^2 E_o = k_1 m_1 \tag{4.4}$$

and

$$4\pi r_2^2 E_o = k_2 m_2 \tag{4.5}$$

Let S1 and S2 be now placed with their centers separated by a distance of d, as shown in Fig. 1. The two spheres would thus shield each other from a part of the CMB onslaught, causing between them – a CMB void. The resulting force imbalance across hemispheres causes thereby each body to be pushed toward, or be seemingly attracted to, the other.

AND THIS, BASICALLY, IS THE GRAVITATIONAL EFFECT BETWEEN CELESTIAL BODIES.

Figure 1 shows the two analytical – or gravitational – spheres S1 and S2, but detailing only the CMB shielding of S1 by S2

Considering S1, the left hemisphere faces the full CMB impact. However, on the right hemisphere, the impact force on segment O_1XY of the sphere gets blocked by S2. And this force, say, F, or the lack of it, causes S1 to be sucked or pushed toward S2.

Now, from fluid mechanics, the force, F, on the spherical surface area XY under pressure, A_o, is the same as the force on the flat, circular (cut-away) area, of radius b, at XY under the same pressure, A_o. (Area of the latter surface is therefore πb^2.)

That is,

$$F = \pi b^2 A_o \tag{4.6}$$

From Fig. 1, it is also now easily shown that:

$$b/r_1 = \sin\theta = r_2/d \quad (4.7)$$

Whence, from the above seven equations, we get,

$$\boxed{\mathbf{F = Gm_1m_2/d^2} \quad (4.8)}$$

where

$$\boxed{\mathbf{G = k_1k_2/8\pi E_oc} \quad (4.9)}$$

Equations (4.8) and (4.9) show F to be mutual between the two bodies. That is, if suffixes 1 and 2 are interchanged in the equations, force F would still remain the same, showing the CMB shielding of *S2 by S1* to be the same in magnitude.

The CMB energy per unit area per unit time, E_o, and its velocity, c, may be justifiably taken as universal constants, but not the factors k_1 and k_2. Thus, G can be considered the gravitational constant only for the particular pair of bodies considered. This is the fundamental reason why experiments to measure G will keep on showing varied results (Schwarzschild 2002), let alone a universal constancy, even for the same quantity of matter (mass) but of different form, shape, chemical composition or even ambient conditions. It is thus now easily predicted: The more varied and refined the experiments, the more diverse will be the value of G.

We arrive next at, perhaps, the most important crossroads of all in science – where we shall see, in the new light, that long-sought union taking place between quantum mechanics and relativity.

– End of Part 1 of 2 –