

Unification of Fundamental Forces at High Radiation Temperature in the Creator, “The Consuming Fire”

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Abstract

Unification of the fundamental forces—gravity, electromagnetism, and the strong and weak nuclear forces, possibly at the quantum level—has been the highest quest of modern physics but has not been found in a set of field equations or “theory of everything.” These diverse forces of widely varying strengths using different constants and units are not reducible to a single phenomenon at the current low temperature state of the universe. An evolutionary, big bang origin of the universe is not advocated. Nevertheless, radiation temperature is shown to be a parameter of unification, and although introduction of this concept does not end in a comprehensive unified theory, it points to unification in the Creator, the God of the universe, in His singularity conditions, beyond natural law and quantification.

Introduction

“And to the eyes of the sons of Israel the appearance of the glory of the Lord was like a *consuming fire* on the mountain top.”

Exodus 24:17[†]

“And the mountain burned with fire to the *very heart* of the heavens ... For the Lord your God is a *consuming fire*.”

Deuteronomy 4:11, 24

“For our God is a *consuming fire*.”

Hebrews 12:29

Einstein’s dream, on which he worked for the last 36 years of his life, was to unify the fundamental laws of physics—gravitation, electromagnetism, and the nuclear forces—with quantum mechanics in one set of field equations. Abraham Pais, speaking of Einstein’s vision, said,

He was looking for a unified field theory, but to him that concept meant something different from what is meant and means to everyone else. He demanded that the theory be strictly causal, that it shall unify gravitation and electromagnetism, that the particles of physics shall emerge as special solutions of the general field equations, and that the quantum postulates *shall be a consequence* of the general field equations.” (Pais, 1982, p. 465).

Einstein himself said in 1949, “Our problem is that of finding the field equations of the total field.” (Pais, 1982, p. 465). Einstein failed in this quest, and there have been no complete candidate theories unifying all the forces with quantum mechanics. Again, from Pais’s definitive biography: “What drove Einstein to this search? ... the answer has to do with a grand design which Einstein conceived early, before the discovery of quantum mechanics ... of particles and fields in which general relativity and quantum theory would be

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[†] All Scripture references from the NEW AMERICAN STANDARD BIBLE, 1977, by the Lockman Foundation. Used by permission.

synthesized. This he failed to achieve. So to date ... an all-embracing theory does not exist" (Pais, 1982, p. 31). It may be that unification is ultimately realizable only in the nature of the Creator Himself.

Unification of the fundamental forces is postulated to exist at high temperature in theoretical models of the early universe and in the singularity conditions predicted inside a black hole. At high temperature, gravity, electromagnetism, and the nuclear forces may be unified due to the convergence of the values of the coupling constants for these different types of forces (Georgi, 1989; Dimopoulos, Raby, and Wilczek, 1991). Shielding of the core of a particle from other particles is thought to be the physical reason coupling constants vary with energy. A *coupling constant* is a number inserted in a theory to fix the strength of a force, for instance on a Feynman diagram. Unification of these diverse forces into one expression or source equation has been the enduring dream of physics, and unification may occur at high temperature. All interactions must be unified in this singularity condition, but the equation of this state as a source expression for all the fundamental forces has yet to be found. Analytically combining these distinct forces exerted over vastly differing distance ranges and strengths with unique constants and units has eluded physicists since Einstein, and has now become the search for a "theory of everything" that attempts to incorporate all physical phenomena into this one set of equations. The comprehensive description of unification is realizable only in the unapproachable nature of the Creator Himself. Radiation temperature, however, may provide a measure of unification.

Temperature is implicitly understood as the defining scale of unification since this state at high temperature is central to cosmological models in standard thermal histories of the universe. This article develops such a black-body equivalent unification temperature of fundamental constants where force distinctions break down, a "fusion temperature" of fundamental forces similar to Planck temperature, but as the result of gravitational, electromagnetic, and quantum arguments rather than from dimensional analysis alone. This is proposed as one scientific description of unification consistent with the revealed Creator of the Bible.

A Unification Source Temperature

To unify forces, we can begin to relate large-scale gravity with electromagnetic and nuclear forces with a simplification of the gravitational field equation of a point mass in terms of the curvature of space, $K(r)$, as

$$K(r) = -\frac{GM}{c^2 r^3} \quad (1)$$

(Berry, 1976, pp. 72–73). Using dimensional analysis, Berry shows that this equation for the curvature is the simplest one giving the spatial curvature near an isolated mass M , and which gives a curvature directly proportional to the mass M . According to dimensional analysis, equations are possible in which the curvature is proportional to a higher power of M ; however, according to Berry, equation (1) is the one that emerges rigorously from Einstein's field equations within the condition of non-oscillating spatial curvature near an isolated mass. If we then evaluate this curvature at the Schwarzschild radius of a black hole, $R_s = 2GM/c^2$, then

$$K(R_s) = -\frac{c^4}{8G^2 M^2} \quad (2)$$

where M is the total mass of the gravitational source inside R_s . This mass is equivalent to energy by Einstein's equation, so we can write for a mass, M , equivalent to radiant energy, $E = Mc^2 = aT^4V$ in a volume V where a is the radiation constant:

$$\frac{M}{V} = aT^4 / c^2 \quad (3)$$

Here mass density is equivalent to black-body radiation energy density at temperature $T(K)$ in a volume V , and, although a theoretical mass-energy transformation, it could be realizable at a high enough temperature. An example of this equivalence of mass and radiant energy is photon capture near a black hole. Since a black hole would gain a background radiation black-body photon at the Schwarzschild radius, then, by conservation of energy, the mass of the photon would increment the mass of the black hole. Photon energy is thus transformed into gravitational potential energy of the black hole at R_s , and is equivalent.

If we then let V in equation (3) be the Schwarzschild volume V_s , and with spherical geometry, $V_s = (4/3)\pi R_s^3 = M_s c^2 / aT_s^4$, transposing and combining this with equations (1) and (3) yields,

$$K(R_s) = -GM_s / c^2 R_s^3 = -4\pi aGT_s^4 / 3c^4 \quad (4)$$

And this means that from equations (2) and (4),

$$c^4 / 8G^2 M_s^2 = 4\pi aGT_s^4 / 3c^4 \quad (5)$$

Therefore,

$$T_s^4 = 3c^8 / 32\pi aG^3 M_s^2 \quad (6)$$

Here T_s is the estimated black-body radiation temperature inside R_s due to the compression of mass M_s into a black hole. This energy is not observable outside of R_s due to the trapping of all radiation inside the event horizon. Substituting for the radiation constant, $a = 8\pi^5 k^4 / 15c^3 h^3$, equation (6) becomes

$$T_s^4 = \frac{45c^{11}h^3}{256\pi^6 k^4 G^3 M_s^2} \quad (7)$$

where k and h are Boltzmann and Planck constants. Returning to the definition of the Schwarzschild radius, $M_s^2 = R_s^2 c^4 / 4G^2$, then

$$T_s^4 = \frac{45c^7 h^3}{64\pi^6 k^4 G R_s^2} \quad (8)$$

If we now let the Schwarzschild radius R_s collapse to the Compton wavelength of a particle, $\lambda_c = h/mc$, the fundamental limit on measuring the position of a particle of *rest mass*, m ; then R_s now approaches the length scale where a relativistic quantum field theory becomes necessary for a complete description. This is the shortest quantifiable distance consistent with Heisenberg uncertainty, and for an electron as the smallest rest mass particle that has electric charge and can be acted upon by gravity. The electron cannot be localized within a shorter length than λ_{ce} . The Compton wavelength can be considered the junction length of classical, relativistic, and quantum mechanics, therefore λ_c is the limit to which R_s can be reduced. Substituting the electron Compton wavelength λ_{ce} for R :

$$T_{uce} = \left(\frac{45c^7 h^3}{64\pi^6 k^4 G \lambda_{ce}^2} \right)^{1/4} = \left(\frac{c^9 h m_e^2}{1.42 \pi^6 k^4 G} \right)^{1/4} = 2.4 \times 10^{20} \text{ K} \quad (9)$$

This is the estimated unification temperature inside R_s reduced to the limit of the Compton wavelength of the electron to couple gravity with electromagnetic interactions. This is a unique equation of all constants derived from classical, relativistic, and quantum-radiation arguments, and not dimensional analysis alone as in the case of Planck temperature. The Compton wavelength of the electron is first used as the smallest rest mass, charged particle fundamental to all matter, and the energy exchange particle of quantum-electromagnetic interactions. To extend this to nuclear interactions and the “strong” force, at the other end of the real particle spectrum is the proton, the largest stable rest mass particle (the neutron is not stable unless it is bound inside a nucleus) fundamental to all matter beginning with the hydrogen atom. Now, substituting the proton Compton wavelength of the nucleus, λ_{cp} , for

λ_{ce} in equation (9) to further reduce the event horizon to the characteristic length scale of nuclear interactions, then

$$T_{ucp} = \left(\frac{c^7 h^3}{1.42 \pi^6 \lambda_{cp}^2 k^4 G} \right)^{1/4} = 1.02 \times 10^{22} \text{ K} \quad (10)$$

This is an equation of all the constants of the fundamental forces and quantum mechanics yielding a very high temperature to attain unification conditions at the scale of the Compton wavelength of the proton. The proton is chosen as the rest mass particle basic to all the elements at the heart of matter, the nucleus, where λ_{cp} is the fundamental interaction length of the strong nuclear force. This equation may define a fundamental temperature in the singularity where all forces must be unified at the intersection of gravity, relativity, electromagnetic, and nuclear interactions and quantum mechanics; a quantum-radiation temperature relation between the fundamental forces of nature. *Equation (10) is a unifying concept for gravity, electromagnetism, and the nuclear forces where they become equal, where one constant incorporates all the forces. This means that these forces are the same phenomena at this high temperature.*

It should be noted that there is not universal agreement with equating the Schwarzschild radius with the Compton wavelength of a particle, although $h/mc = 2Gm/c^2$ is the generally accepted step in the definition of Planck mass, “Planck particles,” and other Planck limit quantities. In their recent paper, “Planck Particles and Quantum Gravity” Crothers and Dunning-Davies (2006, pp. 70–73), question whether this is an adequate basis for defining Planck particles, which they state may not exist, and the physical relevance of equating the Compton wavelength (“which is Euclidean”) with the Schwarzschild radius (“inherently non-Euclidean”). However, the Schwarzschild radius is an established definition of the event horizon of a black hole, and this paper is not defining “Planck particles” or asserting their existence, but using R_s and λ_c as established physical boundaries; and both can be described as Euclidean as the authors state on page 71 of their paper. The Schwarzschild radius and Compton scale are used here as well-defined limits.

It is postulated in the standard model of particle physics that at some high temperature, force distinctions break down (e.g. see Roos, 2003, pp. 176–177). This is quantified in equation (10), resulting in a temperature in the unification region but below Planck temperature ($T_{pl} = E_{pl}/k = m_{pl}c^2/k = (hc^5/2\pi Gk^2)^{1/2} = 1.42 \times 10^{32} \text{ K}$). This radiation temperature may be a threshold where fundamental forces become unified or “fuse” in the singularity of the black hole, where forces lose distinction at the limit where gravity meets quantum physics at a high black-body radiation temperature. Although advo-

cating an evolutionary, big bang origin for the universe over billions of years would be a mistake and is not being proposed here, there nevertheless seems to be a physical basis for this “unification temperature.”

Analysis of a Unification Temperature

The black-body-equivalent radiation temperature of 10^{22} K of equation (10) is a high temperature in theoretical thermal histories of the universe. At 10^{11} K corresponding to a mean energy of 300 MeV, according to Roos, the primordial hot plasma had cooled sufficiently for nucleosynthesis of the elements (Roos, 2003, p. 130). (Absolute temperature is here a measure of average energy by the dimensional relation $E = kT$ where k is Boltzmann's constant.) In standard model nucleosynthesis, nuclear fusion reactions occur in the range of 2.22–7.72 MeV (Roos, 2003, p. 140). So, after some primordial phase transitions occurring in some current theories of the early universe, temperature is the defining parameter at $E \approx 200$ MeV or $T(K) = 2.32 \times 10^{12}$ K as theorized by Roos and others (Roos, 2003, p. 172).

Projecting to temperatures and energies greater than 10^{12} K or 200–300 MeV, grand unified theory (GUT) interactions begin. The unification of weak nuclear and electromagnetic forces in the electroweak interaction is thought to occur as the temperature increases through 10^{15} K in the energy range of 1–100 GeV (Roos, 2003, pp. 173–174), resulting in a “thermal soup of quarks, gluons, leptons, and photons.” This is the theoretical mass-energy transformation range of W and Z particles and the Higgs boson, according to Roos, and at this energy there is no distinction between weak nuclear and electromagnetic interactions. If we continue this temperature rise to 10^{16} K at 10^3 GeV or 1 TeV, this is now the range where our models of the universe are no longer testable through experiment due to the limits of present-day accelerators. Here we encounter phase transitions beyond electroweak interactions and reach the threshold of supersymmetry (SUSY) theory. Still higher are $1\text{--}10^{12}$ TeV energies corresponding to temperatures of $10^{16}\text{--}10^{28}$ K, which bound the 10^{22} K temperature of equation (10). This is the threshold of “new physics” required in this energy range, since no known laws of physics hold here (Roos, 2003, pp. 174–176). Above this is 10^{12} GeV $< E < 10^{16}$ TeV, or 10^{19} GeV on the energy scale as the upper energy limit corresponding to the Planck temperature of 1.16×10^{32} K. This is the theoretical limit where GUTs and unification and breakdown of all forces has occurred, but it requires introducing large numbers of new particles, vector bosons and Higgs scalars, all of which are yet to be discovered (Roos, 2003, p. 177). 10^{19} GeV is the Planck limit where gravitational and quantum effects are of equal importance. The 10^{22} K result is therefore consistent with

creation nucleosynthesis and thermal models of the universe as a possible unification threshold temperature.

Finally, it is significant to see how the derived unification temperature compares with recent experiments to create a quark-gluon plasma (QGP) reported at Brookhaven National Laboratory in the Relativistic Heavy Ion Collider (RHIC). Experiments in the RHIC are intended to break down fundamental particles such as protons in high-energy nucleon collisions, and this is to induce phase transitions from ordinary nucleon or hadronic matter states into constituent quarks and gluons in a QGP generally thought to be the state of the early universe. Results are preliminary as to whether a large density of quarks and gluons, or “partons” has been created yet (Arsene et al, 2005, p.2). These researchers define a critical temperature in which these intended phase transitions should occur, $T_c \approx 175$ MeV (or less than 10^{12} K), based on the fundamental theory of strong interactions and quantum chromodynamics, but they state it is not at all clear whether transition to the QGP has occurred (Arsene et al, 2005, p. 4). These results from the first round of RHIC experiments clearly show that high-energy nucleon-nucleon collisions have moved to a “qualitatively new physics domain” and that relative abundances of many different particles containing the “three lightest quark flavors” were achieved at a temperature in the vicinity of $T = 175$ MeV (Arsene et al, 2005, p. 26). From this it is apparent experimentally that QGP phase transitions begin at energies around 175 MeV with the identification of some quarks, but complete phase transition to a QGP has not occurred at this energy level, which corresponds to a temperature of 10^{12} K, below the derived threshold unification temperature of 10^{22} K of equation (10). Higher energies at RHIC and in other accelerators should clarify these phase transition temperatures in the future.

High-Temperature Unification as an Aspect of God's Manifest Nature and Glory as “The Consuming Fire”

There are numerous references in both the Old and New Testaments to high-temperature, bright thermal radiation as a fundamental aspect of God's revealed nature. His infinite, manifold attributes are much beyond His observable radiance in these cases, but it is apparent that thermal radiation is integral to His manifest glory. The first revelation of God to the Israelites during the Exodus was as a pillar of cloud by day and pillar of fire by night (Exod. 13:21; 14:19–20; Num. 14:14; Deut. 1:33; Neh. 9:12, 19; Ps. 78:14), and in Exodus 24:17, where they first see His glory manifested as fire on Mount Sinai, Moses records “And to the eyes of the sons of Israel the appearance of the glory of the Lord was like a consuming fire on the mountain top.” The only analogy they

can make observationally is to describe Him as a “consuming fire,” or devouring fire that entirely consumes. This follows from God’s earlier visit to Mount Sinai as recorded in Exodus 19:18: “Now Mount Sinai was all in smoke because the Lord descended upon it in fire.” Fire is the most striking attribute of His nature. A parallel passage is Deuteronomy 4:11–12 reads, “*The mountain (Mount Sinai) burned with fire to the very heart of the heavens ... Then the Lord spoke to you from the midst of the fire*” (emphases added), reiterating this aspect of God’s presence. In the New Testament, Hebrews 12:29 declares, “For our God is a consuming fire.”

The fact that God Himself *is* a consuming fire, cited in both the Old and New Testaments, shows how central this is to His nature. Another passage linking bright thermal radiation to the nature of God is Ezekiel 1:1, where the prophet declares, “The heavens were opened and I saw visions of God,” and later in verse four, “As I looked, behold, a storm wind was coming from the north, a great cloud with fire flashing forth continually and a bright light around it, *and in its midst something like glowing metal in the midst of the fire*” (emphasis added). This is a clear reference to God’s manifest glory in thermal radiation, “something like glowing metal.” Later in Ezekiel 1:26–28 we read, “Now above the expanse that was over their heads there was something resembling a throne, ... and on that which resembled a throne, high up, was a figure with the appearance of a man ... from the appearance of His loins and upward *something like glowing metal that looked like fire all around within it, and from the appearance of His loins and downward I saw something like fire; and there was a radiance around Him ... Such was the appearance of the likeness of the glory of the Lord*” (emphases added). Ezekiel is recording the indescribable God of glory in definitive thermal radiation terms.

Unification of fundamental forces at high radiation temperature proves that the unified source of those forces is the God of the universe, the Consuming Fire. High radiation temperature in this connection is a manifestation of His nature recorded in Scripture from Exodus to Hebrews: “The God who answers by fire, He is God” (1 Kings 18:24); “Then the fire of the Lord fell” (1 Kings 18:38). Both Psalm 104:4 and Heb. 1:7 speak of, “flaming fire His ministers,” and in Psalm 18:8, “Fire from His mouth devoured; coals were kindled by it,” is another reference to radiant thermal energy. Isaiah 29:6 speaks of “the flame of a consuming fire,” and Isaiah 30:30 says, “And the Lord will cause His voice of authority to be heard ... and in the flame of a consuming fire.” This relationship between God as a consuming fire and His creation and origin of the fundamental forces is best summarized in 2 Peter 3:10 and 12 regarding the future day of the Lord “when the Lord Jesus shall be revealed from heaven with His mighty angels in flaming fire” (2 Thess. 1:7): “But the

day of the Lord will come like a thief, in which the heavens will pass away with a roar and the elements will be destroyed with intense heat ... the day of God, on account of which the heavens will be destroyed by burning, and the elements will melt with intense heat!” This is the ultimate destruction of the universe from the grandest scale of the heavens (gravity, electromagnetic radiation) to the smallest scale of the elements (nuclear, quantum-electromagnetic forces), where these forces are fused together by thermal radiant energy and the elements melt down or melt together. Temperature is a unifying parameter that spans from the heavens to the elements, the fundamental particles, and is the agent of their ultimate dissolution. These forces are necessarily unified in this state from God Himself, the ultimate singularity, and this is the connection between the Creator of the universe as the unified source of fundamental forces and His nature as a consuming fire.

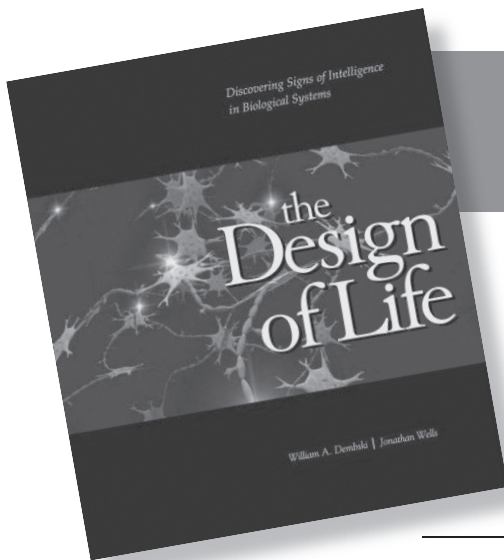
Summary

The result of equation (10) is a black-body-equivalent radiation temperature describing unification conditions inside the Schwarzschild event horizon reduced to the Compton quantum wavelength scale of the fundamental stable, rest mass nucleon, the proton. This is a real temperature based on more constants than Planck temperature: c , h , k , G , and λ_{cp} , which are fundamental to relativity, quantum mechanics and electromagnetic radiation, thermodynamics, and gravity. Equation (10) may be a radiant energy source expression for fundamental forces, since it incorporates all the force constants and shows that the underlying connection between forces may be thermal in nature with $T(K)$ the unifying parameter. This is also suggested by scriptural references to the Creator as “the Consuming Fire” and source of thermal consummation of all things. Unification of forces will never be found in a “theory of everything” but only understood in the nature and attributes of the “God of everything,” the Creator of the universe revealed in the Scriptures. Unification at high radiation temperature is a basis for quantifying unification of forces in terms of temperature at the junction of these force domains where unification occurs and is described by fundamental constants. Inside the event horizon of a black hole, an extremely warped space-time is thought to exist, which would be all that is left of the matter that crossed the event horizon and descended to its end at the singularity. We cannot observe what happens inside a black hole and live; similarly Scripture states that no man can see God and live (Exodus 33:20; cf. John 1:18).

The unified source of all force interactions, discoverable only at the extreme limits of radiation temperature, is God Himself, the Creator and Sustainer of the universe.

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Book Review

The Design of Life: Discovering Signs of Intelligence in Biological Systems

by William A. Dembski and Jonathan Wells

The Foundation for Thought and Ethics, Dallas, 2008. 361 pages, \$35.00.

The Design of Life (DOL) should be read not only by those who think that evolution (Darwinism) is the best viewpoint, but also by anti-Darwinians, who will encounter additional evidence supporting their position. DOL is the sequel to *Of Pandas and People* (1993), in which intelligent design (ID) had been proposed “as a scientific alternative to Darwinian evolution” (DOL, p. xv).

Both of the above books were commissioned by Jon A. Buell, president of The Foundation for Thought and Ethics in Dallas. The first book was more tentative; DOL is thorough. A solid foundation for ID now is in place.

Coverage in DOL includes a dedication honoring Drs. Paul and Margaret Brand, a forward by W. S. Harris, and a preface by J. A. Buell. Topics include the meanings of evolution, human origins, genetics and macroevolution, the fossil record, the origin of species, similar features, irreducible complexity, specified complexity, the origin of life, and an epilogue

discussing “Inherit the Wind,” “The Santorum Amendment,” and “*Kitzmiller v. Dover*.”

There are 32 pages of endnotes, a 13-page glossary, and a 15-page index citing topics in the book and additionally on the accompanying CD, which greatly supplements the endnotes. I opened the CD using Adobe Reader 8. Following the index is one page about the authors and two pages of credits. Discussion questions are located at the chapter ends of DOL. The book is adorned throughout with color photographs, drawings, and backgrounds.

DOL is scholarly and a very appropriate gift for libraries, scientists, and discerning layperson friends and relatives.

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