Newton was right: Light is particles

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Abstract:
A particle model of light (complete in all respects), in which the particles move along helical paths, is proposed. How these particles acquire varying charges and integrate into systems called e-m radiations are explained; the probable physical constants have been deduced. This model replaces 'space-time' by 'gravitational dragging' and 'wave-particle duality' by 'particles following wavy path'. So, if the model is correct, the two great theories of modern physics, 'General Relativity' and 'Quantum Mechanics' will have to be abandoned.

Key words: Fundamental particles, charge, three-dimensional wave-patterns, Quantum-length, Time-quantum, Space-quantum, Quantum-jump.

(Note: The deduction of the proposed physical constants is given as appendix)

1. Introduction:

Huygens explained light as waves; Newton regarded light as particles; Maxwell proposed that light is actually ‘fields carrying energy’ propagating as waves; and Einstein added that the energy of the fields is quantized. The present model is a combination of these views: basically light is taken as a disturbance in the electromagnetic field; wave, quantum and particle natures are then incorporated into it. Though the model can explain the properties exhibited by electromagnetic radiations, it is silent about the physical structure of these.

In this paper, I propose an alternate model: basically, light is taken as particles; wave, quantum and field natures are then incorporated into that model. This model can also explain the properties. The relative merit is that it proposes clear physical structures. The new model is based on the concept that motion at speed 'c' is the fundamental property of matter, and force is reaction to this motion[1].

2. The particles of light:

The particle of light is the smallest possible particle or fundamental particle[2] of matter (mass: 1.0007×10^{-47}kg, radius: 3.0717×10^{-23}m). Motion at speed 'c' is its basic property. Energy is motion, and force is reaction to motion. So both the energy and the force of the particle are equal to $mc^2/2$ (in energy units). The force created is mainly gravity; that is, the particle has a strong gravitational field. Due to the reaction to motion, the particle is confined to a closed path (period of revolution 62.56 billion years).

The fundamental particles exist in pairs; the particles in a pair remain separated by a small distance, $2r_h$. The pair rotates as it moves forward. The forward path is a circle of very large radius (about 2.5 billion light years). So the individual path of each particle is a helix having a circular axis. The axis being circular, the turns of the helix are closer in the inner side, and this affects the speed. The speed of each particle varies from $c+\Delta c$ to $c-\Delta c$ during each rotation. This creates a varying potential state, which we can identify as a varying *charge* [3]. Thus, a moving pair creates a varying electromagnetic field.

The electrical field line starts from the particle remaining in the inner side of the circular axis and ends in the other. The magnetic filed line is a closed loop perpendicular to the electrical field line. The gravitational field line starts from each particle and ends at the common center, which lies on the axis. The forces emanate from the common center, and not from the particles. The pairs can integrate into rings/shells (radius same as that of the helix). Neutrino radiations contain rings[2], and electron/positron contains shells[4].

3. **Streams of particle-pairs:**

Electromagnetic radiations are streams of such rotating pairs. Due to interactions, the distance between the pairs in a stream will be uniform, and so the moving pairs create a pair of *three-dimensional wave-patterns* (a double helix of radius r_h). The number of particles in a wavelet is the number of particles that can be accommodated in the circumference of the helix, and is the same for all radiations (n = 42960400), but the wavelength depends on the distance between pairs. The smaller the wavelength, the greater is the number of pairs per unit length, and greater the energy of the radiation.

The electrical field lines of the pairs in a stream exist in various planes. If resolved into two perpendicular planes, the components in the plane of the circular axis will have the same direction, and will be varying from zero to the maximum and back. But the direction of the perpendicular components reverse in each half period of rotation, and thus get canceled. So the net electrical field of the wave-patterns remains in the plane of the circular axis, and is wavelike. Consequently, the net magnetic field is also planar and wavelike. Thus the electrical field, magnetic field and the direction of forward motion of the particles are in three mutually perpendicular directions.

As the wave-patterns exist in pairs, their fields form a planar electromagnetic wave-pair, the crust of one lying diametrically opposite to the trough of the other. The electro-magnetic wavelength is thus half the wavelength of the wave-patterns, but it contains two halves of the wave-pattern pair, and so the number of particles in an e-m wavelength is also 'n'. The electrical field lines are always directed outwards with respect to the center of circular axis and so the direction of the field indicates the path of the stream. Changing the plane of the electrical field implies altering the path of the stream.

4. **Quantum as a physical structure:**

The three-dimensional wave-patterns are not continuous. It is split into discrete physical units, which we can identify as quanta. A single ray is a ‘stream of quanta’ held together by gravity. A ray can be viewed as divided into length units of 2L, the pairs being confined within the central region having length L, which we can identify as '*quantum-length*'. So there is a gap of one quantum length between quanta, and the quanta are thus well separated physical units.

E-m radiations are absorbed and released in quanta. The quantum length 'L' and the radius of helix 'r_h' are the same for all radiations. The former represents length and the latter represents volume. That is, if 2L represents x, $4\pi r_h^2/3$ represents x^3. That is $2L/x = (4\pi r_h^2/3)/x^3$ = 'a dimensionless number' (refer appendix).

5. **Time-quantum, space-quantum and quantum-jump:**

The emission of pairs is deterministic. Pairs having the same initial phase are emitted with a gap of a '*time-quantum*'. The distance between two such pairs is a '*space quantum*', which is equal to 2L, twice the quantum length. A stream containing such pairs forms a wave-pattern pair having a wavelength $\lambda/2$, and e-m wavelength $\lambda/4$ (where λ is the wavelength of a single particle). Each quantum in it contains just one pair. Many such streams in different phases are released synchronously, and these merge into a single stream (each contributing one pair to a quantum), thus giving rise to radiations having different energies.

Time quantum and space-quantum are absolute values of time and distance related to the fundamental particle, and not a relative value like its speed. The motion of the particle can be regarded as quantized; it moves by '*quantum-jumps*', jumping a space quantum in a time quantum, and a series of jumps makes the motion appear to be continuous. Thus everything associated with the fundamental particle are quantized.

6. **Speed of light (e-m radiations):**

As the individual particles of the pair move along helical paths, these have two speeds: the speed along the helix and the speed of forward motion. The former is invariant, but the latter depends on the medium. In vacuum, both speeds are equal to 'c'. The condition for this has been derived in a previous paper[2], and can be given as as $R/r = a^2/2$, where 'a' is the number of rotations of the pair during one revolution. In other mediums, due to the fields present, the forward speed decreases.

Since light has gravitational fields, it is dragged by moving bodies like Earth. Close to the surface of Earth, dragging is complete and the relative speed of light is independent of the direction of motion of Earth. However, at higher altitudes, dragging is partial and the relative speed varies with direction; so, distances measured using light signals require correction. Gravitational dragging can thus explain the observed nature of the speed of light, and the physically-meaningless concept of space-time can be discarded.

7. **Physical constants of the particle and the role of π :**

The mass, radius and speed of the fundamental particle are the only fundamental physical constants. In addition to these, the dimensionless constant 'π' (its whole number ratio) has a major role in deciding the structures. The values of these constants have been deduced (refer appendix) based on proposed models and using the known values namely, the mass of neutron, Plank's constant and the speed of light.

The role of 'π' in deciding the structures of electron and neutron has been explained in a previous paper[4]. In the case of fundamental particle, the size of the helix depends on an eight-digit prime number fraction for π (correct to 8 decimals), 42960403/13674721. The denominator represents the outer diameter (in number of particles) of the helix. The actual diameter, the distance between the centers of the particles at diametrically opposite sides, is one less than this. So the number of particles that can be arranged in the circumference, 'n' = $13674720\pi = 42960400$ (rounded to the nearest whole number).

8. Energy of a quantum:

A quantum may contain a fraction of a wavelet or many wavelets. If λ is the e-m wavelength of a given radiation, the number of particles in its quantum = nL/λ, where 'n' is the number of particles in a wavelet. The energy of the quantum is due to the the kinetic energy of particles in it, and so we have to use the equation for kinetic energy $E=mc^2/2$ (*not* mc^2) for calculating the energy.

$$\text{Energy of the quantum} = (nL/\lambda)\, mc^2/2 = (nLmc/2)\times c/\lambda$$

Thus we get the result that energy is proportional to frequency. The constant, nLmc/2 is equal to 'h', the Plank's constant. So, we can write the equation as, $E = mc^2/2 = h\nu$. Thus the e-m wavelength of a particle is 2h/mc, that is, twice its Compton wavelength.

9. Electromagnetic spectrum, neutron-wave:

The electromagnetic spectrum is neither infinite nor continuous. A quantum containing a single particle, though it cannot exist, can be taken as the lower limit. As the number of pairs in the quantum increases, the pairs come closer and closer. In the limiting stage, the pairs come so close that each uses its whole force to interact with its neighbor, and the quantum has no fields like a neutron[4]. We can identify this as a neutron-wave, and take this as the upper limit, though such a quantum cannot exist.

Neutron-wave represents the limit of integration in the form of radiations, and neutron represents the limit in the form of particles[4]. Both have no fields. So we can logically assume that the mass and wavelength of neutron-wave are equal to that of neutron. Neutron contains electron-positron pairs[4], which are made up of shells of fundamental particles. So, based on the structures of neutron and e-m radiations, we can derive the physical constants of the fundamental particle.

Thus we get the limits of the spectrum as 4.4171×10^{5} m and 2.6392×10^{-15} m. However, quanta having these wavelengths cannot exist. In the quantum having the highest energy, the distance between pairs is such that each uses its whole available force[1] for two interactions to form a chain of pairs; so its mass is half, and wavelength twice, that of neutron. The force of one pair is available to that quantum to form a chain of quanta.

The e-m spectrum is a line-spectrum; the energy difference between two adjacent lines is equal to the energy of one pair. The quantum having the least energy contains just one pair, and its wavelength is 2.2085×10^{5} m. However, in the case of this quantum, the time gap between emission of quanta, which is normally one time-quantum, may increase, and this may create *very low frequency* radiations having no energy- frequency relation.

10. Wavelength- temperature relation:

The relation between temperature and wavelength is given by the equation, $\lambda = b/T$. Why should there be any relation between the two? The structure of quantum implies such a relation. A quantum may contain a very large number of wavelets or a fraction of a wave let. So a quantum containing one pair of wavelets can be taken as the normal state, and any variations as potential states. Its e-m wavelength should represent absolute zero; so, $\lambda_0 = 5.141\times10^{-3}$ m (refer appendix), and this agrees very well with wavelength for 1K.

Wavelengths smaller than λ_0 represent hot state and those greater than λ_0 represent a potential state symmetrically opposite to the hot state, a cold state[5].

Temperature indicates the intensity of hotness. If we use the same scale for measuring the intensity of cold state, the same temperature should represent the same intensity, but the wavelength should increase with intensity. So the temperature- wavelength relation for cold bodies can be given as $\lambda = b_c T$, where b_c is the constant for cold bodies. Thus for a given intensity (temperature), there will be two wavelengths, λ_h and λ_c, and the relation between them can be given as $\lambda_h \times \lambda_c = bb_c$. At absolute zero, both wavelengths are the same and so we get the relation, $\lambda_0^2 = bb_c$. So, $b_c = 9.12\times10^{-3}$ m/K (ref. appendix).

The model thus predicts cold energy. Black-holes are cold bodies[5]. Since temperature indicates the intensity of hotness, we can use negative values for cold state. Wavelength-temperature relations are valid for temperatures sufficiently away from 0K. As it approaches 0K, there will be slight variations, and between 1K and -1K, the relations are completely invalid.

11. Temperature limits, Thermal spectrum and Visible spectrum:

As explained, temperature is related to the structure of the quantum, which in turn is related to the fundamental particle, which has finite properties. So temperature cannot be infinitely high or low. The lower limit corresponds to the wavelength of a single particle. For symmetry, the upper limit should be that much above 0K. So the lower and upper limits of temperature are 4.8433×10^7 K below and above 0K (ref. appendix).

The range of wavelengths emitted by hot bodies constitute the thermal spectrum. So, the lower limit is 5.141×10^{-3} m (corresponding to 0K), and the upper limit is 5.9835×10^{-11} m (corresponding to 4.8433×10^7 K). The geometric mean of these gives 5.55×10^{-7} m, the wavelength of green light, indicating that the visible spectrum lies in the middle region of the thermal spectrum. The temperature corresponding to the mean wavelength (5225K) represents the average temperature of the universe just before expansion started[6].

12. Cooling of a radiation and red shift:

Cooling happens when the distance between pairs increases, and the pairs at the ends of the quantum migrate to the gap between quanta. Thus the number of pairs in the quantum decreases and the wavelength increases. Gradually, the gaps get filled, and the ray splits into two. The process repeats, and the radiation cools. Thus cooling is a deterministic process which involves gradual disintegration of high energy quanta into smaller quanta. The rays are thus red-shifted, but the information is preserved.

In an expanding universe, the radiations cool spontaneously, the rate depending upon the average temperature of the universe. The cosmological red-shift is due to cooling and consequent disintegration of high energy quanta. As the galaxy-clusters move outwards causing expansion[6], the radiations spread out and occupy more space. The new model thus rules out metric expansion and consequent stretching of wavelength.

Hot and cold states are symmetrical. Naturally, cooling is a reversible process; there is no such thing as heat-death. That is, the hot universe will ultimately reach a potential cold state, and will start contracting[6]. As explained in a previous paper[7], the concept of entropy has to be modified to accommodate cold energy. In a contracting universe, the radiations merge together and get heated, or they are blue shifted.

13. Cosmic Background Radiation – a system of e-m radiations:

The Cosmic Background Radiation (now CMBR) is a system of e-m radiations. Pairs, rings and shells made up of fundamental particles[2] represent three different types of integration: linear, planar and spatial. Rings are unstable, but the other two are stable and lead to stable systems, a 'system of e-m radiations' and a 'system of large-scale structures'. The large-scale structures are made up of atoms, which can accommodate a large number of excess particles – these free particles play a crucial role in the transfer of energy between atoms. The atoms can absorb and emit radiations depending upon the circumstances, and thus an equilibrium exists between the two systems.

During expansion, both the systems cool; the rate cooling is the same that at any instant, the average temperature of the large scale structures agrees with the temperature of the CBR. The present temperature of the CBR is close to 0K indicating that the expansion has reached nearly halfway[6]. The radiations emitted by stars and other sources create anisotropies in the CBR. The rate of cooling of these radiations is such that all anisotropies disappear when expansion comes to an end.

14. Predictions based on the model:

'Particles following wavy path' and 'gravitational dragging' are integral parts of the proposed model, and so 'wave-particle-duality/space-time', the two basic concepts on which the two great theories of modern physics 'Quantum Mechanics/General Relativity' are built up, should be wrong if the proposed model is correct. The model thus rejects the two great theories and the world-view based on those. However, the crucial predictions of the model are regarding the path of light, cold energy and age of the universe.

The model predicts that the circular path of light prevents us from observing anything beyond 4.98 billion light years. The so-called *very distant objects* like the quasars and the 'gamma-ray bursts' would have remained within that limit at the time of emission, and now we are observing the returning rays. The circular path makes the rays convergent, and so the brightness is highly magnified. These objects are neither that much far, nor that much bright.

The model predicts cold state; black-holes are cold bodies with temperatures far below absolute zero. Stars emit thermal radiations and black-holes absorb thermal radiations. Both contain atoms/molecules; as their states are symmetrical, the interior of black holes will resemble hot stars. There is neither any dark matter nor any gravitational collapse.

The model predicts that like the fundamental particles, the galaxy-clusters are confined to closed paths, and take 62.56 billion years for one revolution. So the universe is confined to a finite region of space and remains pulsating (period: 62.56 billion years). At the beginning of expansion all bodies are hot and at the end all are cold. At halfway, the average temperature will be 0K. The present temperature is 2.7K; that is, expansion has reached nearly halfway, and so the 'age of the universe' is 15.64 billion years, the same as the period of revolution of light.

15. Conclusion:

The proposed particle model of light is complete in all respects: physical structures are proposed for e-m radiations and quantum; these are correlated to the structures of neutrinos and heavier particles; and the values of all physical constants associated with the particle have been deduced.

The proposed model can explain the particle, quantum, wave and field natures of light. It can explain the invariance of the relative speed of light on Earth's surface, the variations of the speed in different mediums, the bending of light by massive bodies, temperature-wavelength relation, cooling of radiations and red-shift, the existence of CMBR, etc. At the same time, it is devoid of physically meaningless concepts like, space-time, wave-particle duality, independent fields, mass-less particles, mass-giving particle, virtual force-particle, etc.

Based on the above, I claim that the proposed model is better than the existing one. However, it requires further validation: the three crucial predictions, the circular path of light, the existence of cold energy and the proposed age of the universe have to be confirmed through observations/experiments.

Appendix

The physical constants associated with the particle model

The calculation is based on the following:

1. Concepts:

   Energy is motion, and force, reaction to motion[1]. Force and energy of a particle are equal to $mc^2/2$ (in energy units). Force is completely used when two particles touch each other.

2. Known values:
   - mass of neutron, $m_n = 1.6749\times10^{-27}$kg
   - Plank's constant for calculating the e-m wavelength of neutron using the equation, $h\nu = mc^2/2$. E-m wavelength of neutron = $2\lambda_n = 2\times1.3196\times10^{-15}$ m
   - Speed of light 'c' = 2.9979×10^8 m/s.

3. Proposed models:
   - of electromagnetic radiations
   - of electrons/positrons
   - of neutrons
   - of uniform three-dimensional motion

The integration of particles is completely deterministic. The fundamental particles exist in pairs separated by a distance of $2r_h$. The pairs integrate into rings[2] having diameter $2r_h$, and then shells[2] having diameter $2r_h$. Electron/positron contain 155 such shells, and neutron contains 919 electron-positron pairs (155×1838 shells)[4].

Uniform '*one-dimensional motion*' is straight-line motion, uniform '*two-dimensional motion*' is circular motion, and uniform '*three-dimensional motion*' is helical motion around a circular axis. The condition for uniform three-dimensional[2] motion is that the radius of the helix 'r_h' is very small compared to the radius of the circular axis 'R', and the ratio $R/r_h = a^2/2$, where 'a' is a whole number that represents the number of revolutions around the axis during one revolution around the center of the axis.

Deduction of constants:

1. If 'n' is the number of particles in a wavelet, that is, the number of particles that can be accommodated in the circumference of the ring/helix, 'r_h' the radius of the helix and 'r' the radius of the particle, we get the relation,

$$2\pi r_h = 2nr \qquad \text{.............................. (i)}$$

If 'N' is the number of wavelets in a quantum of neutron-wave, then the number of particles in that quantum is 'nN'. So,

The mass of the particle, $m = m_n / nN$, ...(ii)

E-m wavelength of particle $= 2nN\lambda_n$ .... (iii)

2. The force is completely used when two particles touch each other. So gravitational constant of the particle can be calculated as follows.

$$Gm^2/2r = 2mc^2/2$$

$$Gm/2r = c^2 \qquad \text{.................................(iv)}$$

$$G = 2rc^2/m.$$

3. The force is completely used in a neutron-wave, the e-m wavelength of which is $2\lambda_n$. An e-m wavelength contains 2 half-wavelets or n/2 pairs. From equation (iv), it is clear that two pairs should remain at a distance of 4r if the whole force is used. This implies that $2\lambda_n = (n/2)\times 4r = 2nr$. So,

$$r = \lambda_n/n \qquad \text{.......................................(v)}$$

As a quantum length L of neutron-wave contains N wavelets,

$$L = 2\lambda_n N = 2nrN \qquad \text{.............................(vi)}$$

$$L/2r = nN \qquad \text{...........................(vii)}$$

4. As explained in the paper, r_h represents volume and 2L represents length, and the relation between these can be given as, $(4\pi r_h^3/3) / x^3 = 2L/x$. Since radiations contain particle pairs, the length unit 'x' can be taken as 2 particles, that is, 4r. So the equation becomes,

$$(4\pi r_h^3/3) / (4r)^3 = 2L/4r$$

$$\pi r_h^3/48r^3 = L/2r \qquad \text{(Here, } r_h = nr/\pi) \text{ ....refer (i)}$$

So, $$n^3/48\pi^2 = L/2r$$

As per equation (vii), $L/2r = nN$, the number of particles in a neutron/neutron-wave. So the number of particles in neutron,

$$nN = n^3/48\pi^2 \quad \text{................................(viii)}$$

$$\text{So,} \quad N = n^2/48\pi^2 \quad \text{.......................................(ix)}$$

5. The number of particles in a shell of radius 'r_h' can be calculated as follows. The surface area of the shell is $4\pi r_h{}^2$; the thickness of the shell is 2r. So the volume of the shell is equal to $8\pi r_h{}^2 r$. The particles being spherical, the actual volume occupied by them in the shell is only $\pi/6$ of this. Therefore,

Volume of particles in a shell $= 8\pi r_h{}^2 r(\pi/6) = 4\pi^2 r_h{}^2 r/3$.

The volume of a particle $= 4\pi r^3/3$

Therefore, no. of particles in a shell $= \pi r_h{}^2/r^2 = n^2/\pi$. (as $r = \pi r_h/n$)

The number of shells in a neutron is 1838×155. So the number of particles in neutron is equal to $1838\times155(n^2/\pi)$. Equating this to the expression obtained in equation (viii), we get,

$$n^3/48\pi^2 = 1838\times155(n^2/\pi)$$

so, $n = 48\times1838\times155\pi$

$= 13674720\pi = 42960399.89$

$= 42960400$ (Rounding to whole number)

From equation (ix), $N = n^2/48\pi^2$

$= 48\times1838^2\times155^2$

6. The condition for uniform three-dimensional motion is $R/r_h = a^2/2$, where 'a' is the number of primary revolutions (around the axis) during one revolution around the center of the axis. During each primary revolution, the particle moves through a distance of λ, the wavelength of the particle. So $2\pi R = a\lambda$. Or, $a = 2\pi R/\lambda$.

Substituting we get,

$$R/r_h = (2\pi R/\lambda)^2/2 = 2\pi^2R^2/\lambda^2$$

$$R = \lambda^2/2\pi^2 r_h$$

7. From the above, we get the values of the constant as follows:

<u>single particle</u>

Mass	m	$= m_n / nN$	$= 1.0007\times10^{-47}$ kg.
Radius	r	$= \lambda_n/n$	$= 3.0717\times10^{-23}$ m.
Force constant	G	$= 2rc^2/m$	$= 5.5174\times10^{41}$ m^3/kgs
Radius of helix,	r_h	$= nr/\pi$	$= 4.2004\times10^{-16}$ m
Quantum length,	L	$= 2N\lambda_n$	$= 1.0282\times10^{-2}$ m
E-m wavelength	λ_{em}	$= 2nN\lambda_n$	$= 4.4171\times10^{5}$ m
Wavelength	λ	$= 4nN\lambda_n$	$= 8.8342\times10^{5}$ m.
Radius of circular path,	R	$= \lambda^2/2\pi^2 r_h$	$= 9.4127\times10^{25}$ m $= 9.9561\times10^{9}$ LY
Period of revolution		$= 2\pi R/c$	$= 62.556\times10^{9}$ years

particle pair

E-m wavelength	$= \lambda_{em}/2$	$= 2.2085\times10^5$ m
Wavelength	$= \lambda /2$	$= 4.4171\times10^5$ m
Radius of circular path	$= R/4$	$= 2.3532\times10^{25}$ m $= 2.489\times10^9$ LY
Period of revolution		$= 15.639\times10^9$ years

Related constants:

1. The lower limit of electromagnetic spectrum is the e-m wavelength corresponding to a single particle, and the upper limit is the e-m wavelength of neutron.

Lower limit of spectrum $= 4.4171\times10^5$ m (refer above)

Upper limit ----- $= 2\lambda_n$ $= 2.6392\times10^{-15}$ m

2. The wavelength for 0K is the e-m wavelength of the quantum containing one wave-pattern pair, that is L/2 (= 5.141×10^{-3} m). The value matches with the wavelength for 1K (= 2.898×10^{-3} m), a surprising coincidence as far as the model is concerned.

Absolute zero wavelength, $\lambda_0 = L/2$ $= 5.141\times10^{-3}$ m

3. The temperature-wavelength relation for hot bodies is $\lambda = b/T$ and for cold bodies $\lambda = b_cT$. So for any given intensity(temperature), there are two wavelengths, and the geometric mean of these wavelengths gives the the wavelength for absolute zero. The constant for hot bodies (Wein's constant, b = 2.898×10^{-3}) is the wavelength for 1K, and the constant for cold bodies b_c is the wavelength for -1K. So, $bb_c = \lambda_0^2$

So,constant for cold bodies, b_c $= \lambda_0^2/b$

$= (5.141\times10^{-3})^2 / 2.898\times10^{-3}$

$= 9.12\times10^{-3}$ m/K

4. The lower limit of temperature corresponds to the lower limit of the e-m spectrum, and the upper limit is that much above absolute zero.

Lower limit of e-m spectrum	$= 4.4171\times10^5$ m (refer above)
So, Lower limit of temperature	$= 4.4171\times10^5 / b_c$
	$= 4.4171\times10^5 / 9.12\times10^{-3}$
	$= -4.8433\times10^7$ K (cold state)
So, upper limit of temperature	$= 4.8433\times10^7$ K (hot state)
Wavelength of highest temperature	$= 5.9835\times10^{-11}$ m

5. The thermal spectrum extends from 5.141×10^{-3} m (wavelength of absolute zero) to 5.9835×10^{-11} m (wavelength of 4.8433×10^7 K). The visible-spectrum/white-light extends from 380-400nm to 760-780nm wavelengths. The geometric mean of these nearly coincide and represents the wavelength for green light – again a surprising coincidence – indicating that visible spectrum represents the middle region of thermal spectrum.

Geometric mean of thermal spectrum $= 5.5463\times10^{-11}$ m

Geometric mean of white light $= 5.5856\times10^{-11}$ m.

Temperature corresponding to the geometric mean of the thermal spectrum represents the average temperature of the universe just before expansion. Or the universe was white-hot just before expansion[6].

Temperature corresponding geometric mean = $b/ 5.5463\times10^{-11}$

$= 2.898\times10^{-3}/ 5.5463\times10^{-11}$

$= 5225K$

Reference:

[1]. Jose P Koshy, *The Inherent Relation Between Motion and Force (Motion Creates the Forces of Nature)*, http://vixra.org/abs/1312.0176

[2]. Jose P Koshy, *The Fundamental Particle of Matter - Let's call it Photon*, http://vixra.org/abs/1401.0135

[3]. Jose P Koshy, *Unification of Forces: a Complete Model with Theoretical Proof*, http://vixra.org/abs/1402.0103

[4]. Jose P Koshy, *Internal Structures of Electron, Neutron, Proton and Nuclei – Particle Masses Are not Arbitrary*, http://vixra.org/abs/1407.0037

[5]. Jose P Koshy, *Black holes have 'Cold Energy'*, http://vixra.org/abs/1312.0092

[6]. A paper explaining the pulsating model of the universe will be posted in **vixra** soon

[7]. Jose P Koshy, *Redefining 'system' and 'entropy' in Physical Terms*, http://vixra.org/abs/1312.0002