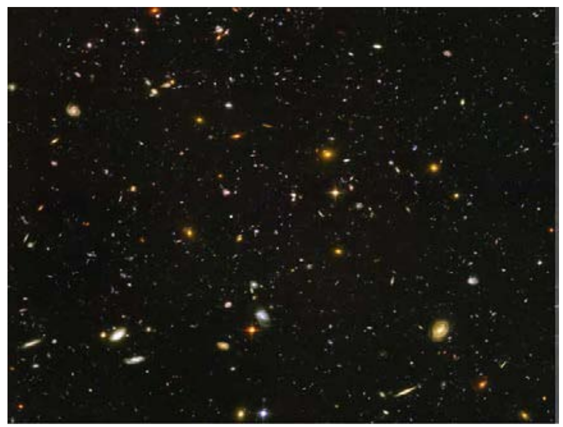
The

Grand Unified Theory

of

Classical Physics

June 2015



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Part 3:

Cosmology

Maxwell's Equations and Special Relativity

Maxwell's equations and special relativity are based on the law of propagation of a electromagnetic wave front in the form

$$\frac{1}{c^2}\frac{\partial^2\omega}{\partial t^2}-\left[\frac{\partial^2\omega}{\partial x^2}+\frac{\partial^2\omega}{\partial y^2}+\frac{\partial^2\omega}{\partial z^2}\right]=0$$

For any kind of wave advancing with limiting velocity and capable of transmitting signals, the equation of front propagation is the same as the equation for the front of a light wave.

Thus, the equation

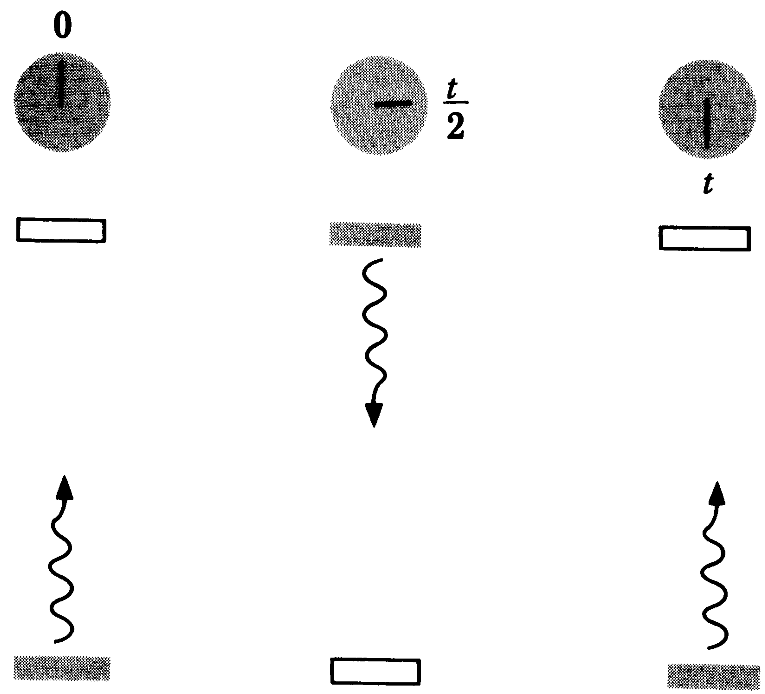
$$\frac{1}{c^2}\left(\frac{\partial^2\omega}{\partial t^2}\right)-\left(grad^2\omega\right)=0$$

acquires a general character; it is more general than Maxwell's equations from which Maxwell originally derived it.

The Classical Wave Equation Governs:

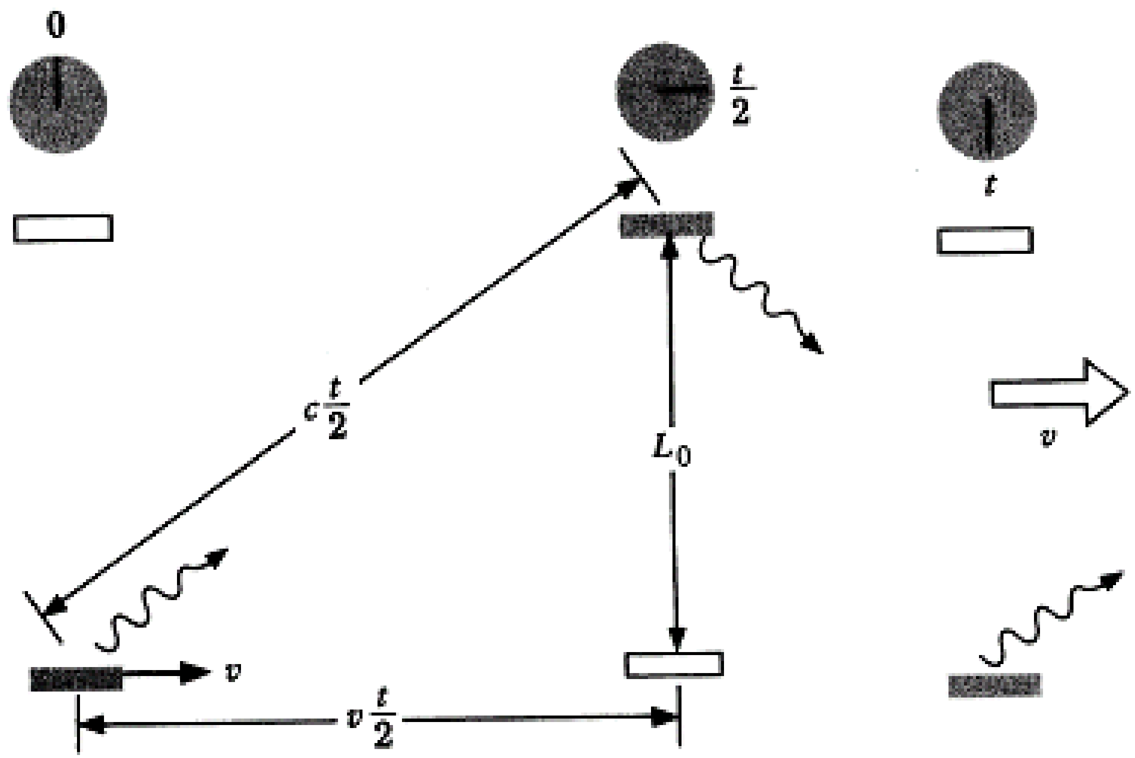
- The motion of bound electrons
- The propagation of any form of energy
- Measurements between inertial frames of reference such as time, mass, momentum, and length (**Minkowski tensor**)
- A relativistic correction of spacetime due to particle production or annihilation (**Schwarzschild metric**)
- Fundamental particle production and the conversion of matter to energy
- The expansion and contraction of the Universe
- The basis of the relationship between Maxwell's equations, Planck's equation, the de Broglie equation, Newton's laws, and special, and general relativity

A Light-Pulse Clock at Rest on the Ground As Seen by an Observer on the Ground



The dial represents a conventional clock on the ground.

A Light-Pulse Clock in a Spacecraft As Seen by an Observer on the Ground



The mirrors are parallel to the direction of the motion of the spacecraft.
The dial represents a conventional clock on the ground.

Time Interval Relation Between Ticks t of the Moving Clock and L_0 , the Vertical Distance Between the Mirrors

$$\left(c\frac{t}{2}\right)^2 = L_0^2 + \left(v\frac{t}{2}\right)^2 \qquad t = \frac{\frac{2L_0}{c}}{\sqrt{1-\frac{v^2}{c^2}}}$$

But $\frac{2L_0}{c}$ is the time t_0 interval between ticks on the clock on the ground, and so the

time dilation relationship based on the constant maximum speed of light in any inertial frame is $t = \dfrac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$

wherein the parameters are:

t_0 = time interval on clock at rest relative to an observer
t = time interval on clock in motion relative to an observer
v = speed of relative motion
c = speed of light

Minkowski Tensor $\eta_{\mu\nu}$

The Metric $g_{\mu\nu}$ for Euclidean Space Called the Minkowski Tensor $\eta_{\mu\nu}$ is

$$\eta_{\mu\nu} = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & \frac{1}{c^2} & 0 & 0 \\ 0 & 0 & \frac{1}{c^2} & 0 \\ 0 & 0 & 0 & \frac{1}{c^2} \end{pmatrix}$$

In this case, the separation of proper time between two events x^μ and is $x^\mu + dx^\mu$

$$d\tau^2 = -\eta_{\mu\nu} dx^\mu dx^\nu$$

The Equivalence of the Gravitational Mass and the Inertial Mass

Experimentally, mass causes time dilation, and $\dfrac{m_g}{m_i} = \text{universal constant}$ which is predicted by Newton's Law of mechanics and gravitation.

The energy equation of Newtonian gravitation

$$E = \frac{1}{2}mv^2 - \frac{GMm}{r} = \frac{1}{2}mv_0^2 - \frac{GMm}{r_0} = \text{constant}$$

Since h, the angular momentum per unit mass, is

$$h = L/m = |\mathbf{r} \times \mathbf{v}| = r_0 v_0 \sin\phi$$

Eccentricity e may be written as

$$e = [1 + \left(v_0^2 - \frac{2GM}{r_0}\right)\frac{r_0^2 v_0^2 \sin^2\phi}{G^2 M^2}]^{1/2}$$

m is the inertial mass of a particle
v_0 is the speed of the particle
r_0 is the distance of the particle from a massive object
ϕ is the angle between the direction of motion of the particle and the radius vector from the object
M is the total (including a particle) of mass of the object

Classification of the Orbits

The eccentricity e given by Newton's differential equations of motion in the case of the central field permits the classification of the orbits.

According to the total energy E:

$E<0,\quad e<1$	ellipse
$E<0,\quad e=0$	circle (special case of ellipse)
$E=0,\quad e=1$	parabolic orbit
$E>0,\quad e>1$	hyperbolic obit

Classification of the Orbits cont'd

According to the orbital velocity relative to the gravitational velocity squared $\frac{2GM}{r_0}$:

$v_0^2 < \frac{2GM}{r_0}$	$e < 1$	ellipse
$v_0^2 < \frac{2GM}{r_0}$	$e = 0$	circle (special case of ellipse)
$v_0^2 = \frac{2GM}{r_0}$	$e = 1$	parabolic orbit
$v_0^2 > \frac{2GM}{r_0}$	$e > 1$	hyperbolic orbit

Continuity Conditions for the Production of a Particle From a Photon Traveling at Light Speed

- A photon traveling at the speed of light gives rise to a particle with an initial **radius equal to its Compton wavelength bar**

$$r = \lambdabar_C = \frac{\hbar}{mc}$$

- The particle must have an **orbital velocity equal to Newtonian gravitational escape velocity** v_g **of the antiparticle**

$$v_g = \sqrt{\frac{2Gm}{r}} = \sqrt{\frac{2Gm_0}{\lambdabar_C}}$$

- The eccentricity is one
- The orbital energy is zero
- The particle production trajectory is a parabola relative to the center of mass of the antiparticle

A Gravitational Field As a Front Equivalent to a Light Wave Front

The particle with a finite gravitational mass gives rise to a gravitational field that travels out as a front equivalent to a light wave front

The form of the outgoing gravitational field front traveling at the speed of light is

$$f\left(t - \frac{r}{c}\right)$$

and $d\tau^2$ is given by

$$d\tau^2 = f(r)dt^2 - \frac{1}{c^2}\left[f(r)^{-1}dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right]$$

The Speed of Light

The speed of light as a constant maximum as well as phase matching and continuity conditions of the electromagnetic and gravitational waves require the following form of the squared displacements:

$$(c\tau)^2 + (v_g t)^2 = (ct)^2$$

$$\tau^2 = t^2\left(1 - \left(\frac{v_g}{c}\right)^2\right)$$

Thus,

$$f(r) = \left(1 - \left(\frac{v_g}{c}\right)^2\right)$$

In order that the wave front velocity does not exceed c in any frame, spacetime must undergo time dilation and length contraction due to the particle production event.

The derivation and result of spacetime time dilation is analogous to the derivation and result of ***special relativistic time dilation*** *wherein the relative velocity of two inertial frames replaces the gravitational velocity.*

Quadratic Form Of The Infinitesimal Squared Temporal Displacement

General form of the metric due to the relativistic effect on spacetime due to mass m_0

$$d\tau^2 = \left(1 - \left(\frac{v_g}{c}\right)^2\right) dt^2 - \frac{1}{c^2}\left[\left(1 - \left(\frac{v_g}{c}\right)^2\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right]$$

Gravitational radius, r_g, of each atomic orbital of the particle production event, each of mass m

$$r_g = \frac{2Gm}{c^2}$$

$$d\tau^2 = \left(1 - \frac{r_g}{r}\right) dt^2 - \frac{1}{c^2}\left[\left(1 - \frac{r_g}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right]$$

Masses and their effects on spacetime **superimpose**. The separation of proper time between two events and x^μ is $x^\mu + dx^\mu$

$$d\tau^2 = \left(1 - \frac{2GM}{c^2 r}\right) dt^2 - \frac{1}{c^2}\left[\left(1 - \frac{2GM}{c^2 r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right]$$

The Origin of Gravity

The Schwarzschild metric gives the relationship whereby matter causes relativistic corrections to spacetime that determines the curvature of spacetime and is the origin of gravity.

The metric $g_{\mu\nu}$ for non-Euclidean space due to the relativistic effect on spacetime due to mass m_0 is

$$g_{\mu\nu} = \begin{pmatrix} -\left(1 - \frac{2Gm_0}{c^2 r}\right) & 0 & 0 & 0 \\ 0 & \frac{1}{c^2}\left(1 - \frac{2Gm_0}{c^2 r}\right)^{-1} & 0 & 0 \\ 0 & 0 & \frac{1}{c^2} r^2 & 0 \\ 0 & 0 & 0 & \frac{1}{c^2} r^2 \sin^2 \theta \end{pmatrix}$$

Particle Production Continuity Conditions

- The photon to particle event requires a transition state that is continuous.
- The velocity of a transition state atomic orbital is the speed of light.
- The radius, r_n , is the Compton wavelength bar, $\lambda\!\!\!{}^{-}_C$

$$\lambda\!\!\!{}^{-}_C = \frac{\hbar}{m_0 c} = r_\alpha^*$$

- The Planck equation energy, the electric potential energy, and the magnetic energy are equal to $m_0 c^2$.

The Masses of Fundamental Particles

The Schwarzschild metric gives the relationship whereby matter causes relativistic corrections to spacetime that determines the masses of fundamental particles.

Substitution of $r = \lambda_C$; $dr = 0$; $d\theta = 0$; $\sin^2\theta = 1$ into the Schwarzschild metric gives

$$d\tau = dt\left(1 - \frac{2Gm_0}{c^2 r_\alpha^*} - \frac{v^2}{c^2}\right)^{\frac{1}{2}}$$

with , $v^2 = c^2$

$$\tau = ti\sqrt{\frac{2GM}{c^2 r_\alpha^*}} = ti\sqrt{\frac{2GM}{c^2 \lambda_c}} = ti\,\frac{v_g}{c}$$

Relationship of the Equivalent Particle Production Energies

When the atomic orbital velocity is the speed of light:

Continuity conditions based on the constant maximum speed of light given by **Maxwell's equations:**

(Mass energy = Planck equation energy = electric potential energy = magnetic energy = mass/spacetime metric energy)

$$m_o c^2 = \hbar\omega^* = V = E_{mag} = E_{spacetime}$$

$$m_0 c^2 = \hbar\omega^* = \frac{\hbar^2}{m_0 \lambda\!\!\!^{-}{}_C^2} = \alpha^{-1}\frac{e^2}{4\pi\varepsilon_0 \lambda\!\!\!^{-}{}_C} = \alpha^{-1}\frac{\pi\mu_0 e^2\hbar^2}{(2\pi m_0)^2 \lambda\!\!\!^{-}{}_C^3} = \frac{\alpha h}{1\sec}\sqrt{\frac{\lambda\!\!\!^{-}{}_C c^2}{2Gm}}$$

Continuity Conditions Based on the Constant Maximum Speed of Light Given by the Schwarzschild Metric

$$\frac{\text{proper time}}{\text{coordinate time}} = \frac{\text{gravitational wave condition}}{\text{electromagnetic wave condition}} = \frac{\text{gravitational mass phase matching}}{\text{charge/inertial mass phase matching}}$$

$$\frac{\text{proper time}}{\text{coordinate time}} = i\frac{\sqrt{\dfrac{2Gm}{c^2 \lambda\!\!\!^{-}_C}}}{\alpha} = i\frac{v_g}{\alpha c}$$

Masses of Fundamental Particles

- **Each of the Planck equation energy, electric energy, and magnetic energy corresponds to a particle given by the relationship between the proper time and the coordinate time.**
- The **electron and antielectron** correspond to the **Planck equation energy**.
- The **muon and antimuon** correspond to the **electric energy**.
- The **tau and antitau** correspond to the **magnetic energy**.
- The particle must possess the escape velocity v_g relative to the antiparticle where $v_g < c$.
- According to Newton's law of gravitation, the eccentricity is one and the particle production trajectory is a parabola relative to the center of mass of the antiparticle.

The Electron-Antielectron Lepton Pair

A clock is defined in terms of a self-consistent system of units used to measure the particle mass.

$$2\pi \frac{\hbar}{mc^2} = \sec \sqrt{\frac{2Gm^2}{c\alpha^2\hbar}}$$

$$m_e = \left(\frac{h\alpha}{\sec c^2} \right)^{\frac{1}{2}} \left(\frac{c\hbar}{2G} \right)^{\frac{1}{4}} = 9.1097 \ X\ 10^{-31} \ kg$$

$$m_{e\,\text{experimental}} = 9.1095 \ X\ 10^{-31} \ kg$$

The Muon-Antimuon Lepton Pair

$$2\pi \frac{\hbar}{mc^2} = 2\pi \sec \sqrt{\frac{2Gm_e\alpha^2 m}{c\hbar}}$$

The mass of the muon/antimuon is

$$m_\mu = \frac{\hbar}{c}\left(\frac{1}{2Gm_e(\alpha \sec)^2}\right)^{\frac{1}{3}} = 1.8902\ X\ 10^{-28}\,kg$$

$$m_{\mu\,\mathrm{experimental}} = 1.8836 \times 10^{-28}\,kg$$

The Tau-Antitau Lepton Pair

$$2\pi \frac{\hbar}{mc^2} = 2\sec\sqrt{\frac{2Gm_e(2\pi)^2\alpha^4 m}{c\hbar}}$$

The mass of the tau/antitau is

$$m_\tau = \frac{\hbar}{c}\left(\frac{1}{2Gm_e}\right)^{\frac{1}{3}}\left(\frac{1}{2\sec\alpha^2}\right)^{\frac{2}{3}} = 3.17\ X\ 10^{-27}\ kg$$

$$m_{\tau\ \mathrm{experimental}} = 3.17\ X\ 10^{-27}\ kg$$

Down-Down-Up Neutron (DDU)

$$2\pi \frac{2\pi\hbar}{\frac{m_N}{3}\left[\frac{1}{2\pi}-\frac{\alpha}{2\pi}\right]c^2} = \sec\sqrt{\frac{2G\left[\frac{m_N}{3}\left[\frac{1}{2\pi}-\frac{\alpha}{2\pi}\right]\right]^2}{3c(2\pi)^2\hbar}}$$

The neutron mass is

$$m_{N\,calculated} = (3)(2\pi)\left(\frac{1}{1-\alpha}\right)\left(\frac{2\pi h}{\sec c^2}\right)^{\frac{1}{2}}\left(\frac{2\pi(3)ch}{2G}\right)^{\frac{1}{4}}$$

$$= 1.6744 X 10^{-27}\, kg$$

$$m_{N\,\mathrm{experimental}} = 1.6749 X 10^{-27}\, kg$$

Strange-Strange-Charmed Neutron (SSC)

$$2\pi \frac{2\pi\hbar}{\frac{m_{ssc}}{3}\left[\frac{1}{2\pi}-\frac{\alpha}{2\pi}\right]c^2} = 2\pi \sec\sqrt{\frac{2G\alpha^2 m_{ddu}\left[\frac{m_{ssc}}{3}\left[\frac{1}{2\pi}-\frac{\alpha}{2\pi}\right]\right]}{3c(2\pi)^2\hbar}}$$

The strange-strange-charmed neutron mass is

$$m_{ssc\,calculated} = (3)(2\pi)\left(\frac{1}{1-\alpha}\right)\left(\frac{h}{\sec c^2}\right)^{\frac{2}{3}}\left(\frac{2\pi(3)ch}{2m_{ddu}G\alpha^2}\right)^{\frac{1}{3}}$$

$$m_{ssc\,calculated} = 4.89\,X10^{-27}\,kg = 2.74\,GeV/c^2$$

The observed mass of the Ω^- hyperon that contains three strange quarks (sss) is

$$m_{\Omega^-} = 1673\,MeV/c^2$$

Strange-Strange-Charmed Neutron (SSC) cont'd

Thus, an estimate for the dynamical mass of the strange quark, m_s , is

$$m_s = \frac{m_{\Omega^-}}{3} = \frac{1673\ MeV / c^2}{3} = 558\ MeV / c^2$$

The dynamical mass of the charmed quark, m_c, has been determined by fitting quarkonia spectra; and from the observed masses of the charmed pseudoscalar mesons $D^0(1865)$ and $D^+(1869)$.

$$m_c = 1.580\ GeV / c^2$$

Thus,

$$m_{ssc\ \text{experimental}} = 2m_s + m_c = 2(558\ MeV / c^2) + 1580\ MeV / c^2$$

$$m_{ssc\ \text{experimental}} = 2.70\ GeV / c^2$$

Bottom-Bottom-Top Neutron (BBT)

$$2\pi \frac{2\pi\hbar}{\frac{m_{bbt}}{3}\left[\frac{1}{2\pi}-\frac{\alpha}{2\pi}\right]c^2} = 2\sec\sqrt{\frac{2G\alpha^4 m_{ddu}\left[\frac{m_{bbt}}{3}\left[\frac{1}{2\pi}-\frac{\alpha}{2\pi}\right]\right]}{3c2(2\pi)^2\hbar}}$$

The bottom-bottom-top neutron mass is

$$m_{bbt\ \ calculated} = (3)(2\pi)\left(\frac{1}{1-\alpha}\right)\left(\frac{2\pi h}{2\sec c^2}\right)^{\frac{2}{3}}\left(\frac{2\pi(3)ch}{m_{ddu}G\alpha^4}\right)^{\frac{1}{3}}$$

$$m_{bbt\ \ calculated} = 3.48\ X\ 10^{-25}\,kg = 195\,GeV/c^2$$

The dynamical mass of the bottom quark, $\mathrm{M_B}$, has been determined by fitting quarkonia spectra; and from the observed masses of the bottom pseudoscalar mesons $B^0(5275)$ and $B^+(5271)$.

$$m_b = 4.580\,GeV/c^2$$

Bottom-Bottom-Top Neutron (BBT) cont'd

Thus, the predicted dynamical mass of the top quark based on the dynamical mass of the bottom quark is

$$m_{t\ calculated} = m_{bbt\ calculated} - 2m_b = 195\ GeV/c^2 - 2(4.580\ GeV/c^2)$$

$$m_{t\ calculated} = 187\ GeV/c^2$$

Considering all jets, the CDF collaboration determined the mass of the top quark to be

$$186 \pm 13\ GeV/c^2$$

Relations Between Fundamental Particles

The relations between the lepton masses and neutron to electron mass ratio which are independent of the definition of the imaginary time ruler *ti* including the contribution of the fields due to charge production are given in terms of the dimensionless fine structure constant α only:

$$\frac{m_\mu}{m_e} = \left(\frac{\alpha^{-2}}{2\pi}\right)^{\frac{2}{3}} \frac{\left(1 + 2\pi \frac{\alpha^2}{2}\right)}{\left(1 + \frac{\alpha}{2}\right)} = 206.76828 \qquad (206.76827)$$

$$\frac{m_\tau}{m_\mu} = \left(\frac{\alpha^{-1}}{2}\right)^{\frac{2}{3}} \frac{\left(1 + \frac{\alpha}{2}\right)}{\left(1 - 4\pi\alpha^2\right)} = 16.817 \qquad (16.817)$$

$$\frac{m_\tau}{m_e} = \left(\frac{\alpha^{-3}}{4\pi}\right)^{\frac{2}{3}} \frac{\left(1 + 2\pi \frac{\alpha^2}{2}\right)}{\left(1 - 4\pi\alpha^2\right)} = 3477.2 \qquad (3477.3)$$

$$\frac{m_N}{m_e} = \frac{12\pi^2}{1-\alpha} \sqrt{\frac{\sqrt{3}}{\alpha}} \frac{\left(1 + 2\pi \frac{\alpha^2}{2}\right)}{\left(1 - 2\pi \frac{\alpha^2}{2}\right)} = 1838.67 \qquad (1838.68)$$

Relations Between Fundamental Particles cont'd

The relations between the masses of members of the neutron family which are independent of the definition of the imaginary time ruler *ti* are given in terms of the dimensionless fine structure constant α only:

$$\frac{m_{ssc}}{m_{ddu}} = \frac{m_{ssc}}{m_N} = \frac{1}{2\pi}\left(\frac{1-\alpha}{3\alpha^2}\right)^{\frac{1}{3}} = 2.926$$

$$\frac{m_{bbt}}{m_{ssc}} = \left(\frac{2\pi^2}{\alpha^2}\right)^{\frac{1}{3}} = 71.8$$

$$\frac{m_{bbt}}{m_{ddu}} = \frac{m_{bbt}}{m_N} = \left(\frac{1-\alpha}{12\pi\alpha^4}\right)^{\frac{1}{3}} = 210$$

Intermediate Vector and Higgs Bosons

Particle energies in collisions may exceed the particle production energies and consequently exceed the corresponding spacetime resonance frequencies during particle production and decay reactions. The relationship between proper and coordinate time has higher order or over-energy resonances due to the same principles regarding the relationship between proper and coordinate time that is the basis of production of the fundamental particles.

Specifically, using the spatial dimensions and the velocity at the electron production event, the scaling factor between the proper and coordinate time is given by:

$$\frac{2\pi\bar{\lambda}_C}{\sqrt{\frac{2Gm_e}{\bar{\lambda}_C}}} = \frac{2\pi\bar{\lambda}_C}{v_g} = i\alpha^{-1}\sec$$

wherein the latter is imaginary because energy transitions are spacelike due to spacetime expansion from matter to energy conversion and v_g is Newtonian gravitational velocity.

The resonance coupling factor g_C for the muon that is a lepton arising from a resonance involving the electron is

$$g_C = 2\pi\alpha^{-1}$$

Applying the resonance coupling factor g_C to the muon production mass having its inherent lepton member, the electron, gives an over-energy resonance E_{Z^0} at

$$E_{Z^0} = g_C m_\mu = 2\pi\alpha^{-1}\frac{\hbar}{c}\left(\frac{1}{2Gm_e(\alpha\sec)^2}\right)^{\frac{1}{3}} = 2\pi\alpha^{-1}(0.10587\ GeV) = 91.16\ GeV$$

Experimentally, the event excess called the intermediate vector boson Z^0 occurs at 91.1876 GeV.

Intermediate Vector and Higgs Bosons cont'd

Similarly, an over-energy absolute spacetime resonance of the electrically neutral neutron $E_{H}{}^{0}$ due to the relationship between proper and coordinate time is predicted at

$$E_{H^0} = \alpha^{-1} m_n = \alpha^{-1}(3)(2\pi)\left(\frac{1}{1-\alpha}\right)\left(\frac{2\pi h}{\sec c^2}\right)^{\frac{1}{2}}\left(\frac{2\pi(3)ch}{2G}\right)^{\frac{1}{4}} = \alpha^{-1}\left(0.93956536\ G\text{eV}\right) = 128.75\ G\text{eV}$$

High-energy proton-proton collisions that produce neutron-antineutron pairs decay to two gamma ray photons or correspondingly two pairs of electron-positron or muon-antimuon pairs. Such an excess of events at 126 GeV has recently been announced by CERN as the discovery the Higgs boson H^0.

A proton is formed via beta decay of the neutron. This requires the initial step of the conversion of a down quark to an up quark having charges -2/3 and +1/3, respectively, with the concomitant formation of an electron of the lepton family having a charge of –1. By considering the corresponding resonance coupling factor g_C and mass-energy corrections to the neutron mass, an over-energy resonance E_{W^-} corresponding to E_{Z^0} is predicted at

$$E_{W^-} = g_C m_\mu \left\{1-\left[\frac{1}{3}\left(1+\left(2\pi\right)^{-2}\right)\right]^2\right\} = 2\pi\alpha^{-1}\frac{\hbar}{c}\left(\frac{1}{2Gm_e\left(\alpha\sec\right)^2}\right)^{\frac{1}{3}}\left\{1-\left[\frac{1}{3}\left(1+\left(2\pi\right)^{-2}\right)\right]^2\right\}$$

$$= 2\pi\alpha^{-1}\left(0.10587\ G\text{eV}\right)\left\{1-\left[\frac{1}{3}\left(1+\left(2\pi\right)^{-2}\right)\right]^2\right\} = 80.51\ G\text{eV}$$

Then, by the symmetry of antiparticles, the positron decay of the antineutron corresponds to W^+. Experimentally, the event excess called the intermediate vector bosons $W^{\pm}$ occurs at 80.423 GeV.

Gravitational Potential Energy

A Fourth Family?

The gravitational radius, α_G or r_{G} , of an atomic orbital of mass m_0 is defined as

$$\alpha_G = r_G = \frac{Gm_0}{c^2}$$

When the $r_G = r_\alpha^* = \lambdabar_C$, the gravitational potential energy equals $m_0 c^2$

$$\frac{Gm_0}{c^2} = \lambdabar_c = \frac{\hbar}{m_0 c}$$

$$\frac{Gm_0^2}{\lambdabar_C} = \frac{Gm_0^2}{r_\alpha^*} = \hbar\omega^* = m_0 c^2$$

Gravitational Potential Energy cont'd

The mass m_o is the Planck mass, m_U ,

$$m_U c^2 = \hbar\omega^* = V = E_{mag} = \frac{G m_U^2}{\lambda_C^*}$$

$$m_U = m_0 = \sqrt{\frac{\hbar c}{G}}$$

The corresponding gravitational velocity, v_G , is defined as

$$v_G = \sqrt{\frac{G m_0}{\lambda_C}} = \sqrt{\frac{G m_u}{\lambda_C}}$$

Relationship of the Equivalent Planck Mass Particle Production Energies

(Mass energy = Planck equation energy = electric potential energy = magnetic Energy = gravitational potential energy = mass/spacetime metric energy)

$$m_o c^2 = \hbar\omega^* = V = E_{mag} = E_{grav} = E_{spacetime}$$

$$m_0 c^2 = \hbar\omega^* = \frac{\hbar^2}{m_0 \lambdabar_C^2} = \alpha^{-1}\frac{e^2}{4\pi\varepsilon_0 \lambdabar_C} = \alpha^{-1}\frac{\pi\mu_0 e^2\hbar^2}{(2\pi m_0)^2 \lambdabar_C^3} = \alpha^{-1}\frac{\mu_0 e^2 c^2}{2h}\sqrt{\frac{Gm_0}{\lambdabar_C}}\sqrt{\frac{\hbar c}{G}} = \frac{\alpha h}{1\sec}\sqrt{\frac{\lambdabar_C c^2}{2Gm}}$$

Equivalent energies give the particle masses in terms of the gravitational velocity, v_G, and the Planck mass, m_U

$$m_0 = \alpha^{-1}\frac{\mu_0 e^2 c}{2h}\frac{\sqrt{\frac{Gm_0}{\lambdabar_C}}}{c} m_u = \alpha^{-1}\frac{\mu_0 e^2 c}{2h}\sqrt{\frac{Gm_0}{c^2 \lambdabar_C}} m_u = \alpha^{-1}\frac{\mu_0 e^2 c}{2h}\frac{v_G}{c} m_u = \frac{v_G}{c} m_u$$

Planck Mass Particles

- A pair of particles each of the **Planck mass** corresponding to the **gravitational potential energy** is not observed since the velocity of each transition state atomic orbital is the **gravitational velocity** v_G that in this case **is the speed of light**; **whereas, the Newtonian gravitational escape velocity** v_g **is** $\sqrt{2}$ **the speed of light.**
- In this case, an electromagnetic wave of mass energy equivalent to the Planck mass travels in a **circular orbit** about the center of mass of another electromagnetic wave of mass energy equivalent to the Planck mass wherein the **eccentricity is equal to zero** and the **escape velocity can never be reached.**

Planck Mass Particles cont'd

- The Planck mass is a "**measuring stick.**" The extraordinarily high Planck mass ($\sqrt{\frac{\hbar c}{G}} = 2.18\ X\ 10^{-8}\ kg$) is the unobtainable mass bound imposed by the angular momentum and speed of the photon relative to the gravitational constant.

- It is analogous to the unattainable bound of the speed of light for a particle possessing finite rest mass imposed by the Minkowski tensor.

Astrophysical Implications of Planck Mass Particles

- The limiting speed of light **eliminates the singularity** problem of Einstein's equation that arises as the radius of a black hole equals the Schwarzschild radius.

- When the **gravitational potential energy density** of a massive body such as a **blackhole** equals that of a particle having the Planck mass, the **matter may transition to photons of the Planck mass/energy**.

- Even light from a black hole will escape when the decay rate of the trapped matter with the concomitant spacetime expansion is greater than the effects of gravity which oppose this expansion.

Astrophysical Implications of Planck Mass Particles cont'd

- Gamma-ray bursts are the most energetic phenomenon known that can release an explosion of gamma-rays packing 100 times more energy than a Supernova explosion.
- The annihilation of a black hole may be the source of γ -ray bursts.
- The source may be due to **conversion of matter to photons of the Planck mass/energy, which may also give rise to cosmic rays**.
- According to the GZK cutoff, the cosmic spectrum cannot extend beyond $5\ X\ 10^{19}\ eV$, but AGASA, the world's largest air shower array, has shown that the spectrum is extending beyond $10^{20}\ eV$ without any clear sign of cutoff. **Photons each of the Planck mass may be the source of these inexplicably energetic cosmic rays.**

The Schwarzschild Metric Gives the Relationship Whereby Matter Causes Relativistic Corrections to Spacetime

- The limiting velocity c results in the **contraction of spacetime due to particle production**. The contraction is given by $2\pi r_g$ where r_g is the gravitational radius of the particle. This has implications for the expansion of spacetime when matter converts to energy
- Q **The mass/energy to expansion/contraction quotient** of spacetime is given by the ratio of the mass of a particle at production divided by T the period of production.

$$Q = \frac{m_0}{T} = \frac{m_0}{\frac{2\pi r_g}{c}} = \frac{m_0}{\frac{2\pi \frac{2Gm_0}{c^2}}{c}} = \frac{c^3}{4\pi G} = 3.22\ X\ 10^{34}\ \frac{kg}{\sec}$$

- The gravitational equations with the equivalence of the particle production energies permit the **conservation of mass/energy** ($E = mc^2$) **and spacetime** ($\frac{c^3}{4\pi G} = 3.22\ X\ 10^{34}\ \frac{kg}{\sec}$).

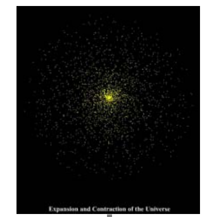
Cosmological Consequences

The *Universe is closed* (it is *finite but with no boundary*).

The **Universe is a 3-sphere Universe**-Riemannian three dimensional hyperspace plus time of constant positive curvature at each r-sphere.

- ***The Universe is oscillatory in matter/energy and spacetime*** with a finite minimum radius, the gravitational radius.

Expanding Spacetime



Expansion and Contraction

Click images above to view animations online

Spacetime expands as mass is released as energy which provides the basis of the **atomic, thermodynamic, and cosmological arrows of time**.

Different regions of space are **isothermal** even though they are separated by greater distances than that over which light could travel during the time of the expansion of the Universe.

Cosmological Consequences cont'd

- Presently, **stars and celestial bodies exist which are older than the elapsed time of the present expansion** as stellar and large scale evolution also occurred during the contraction phase.

- **Observations beyond the beginning** of the expansion phase are **not possible** since the Universe is entirely matter filled.

- The **maximum power** radiated by the Universe which occurs at the beginning of the expansion phase is

$$P_U = \frac{c^5}{4\pi G} = 2.89 \times 10^{51}\ \mathrm{W}$$

Photo Courtesy of NASA, ESA, S. Beck with STCcl and the HUDF Team

The Period of Oscillation Based on Closed Propagation of Light

- Conservation of mass/energy during harmonic expansion and contraction

- The gravitational potential energy E_{grav}

$$E_{grav} = \frac{Gm_U^2}{r}$$

  is equal to $m_U c^2$ when the radius of the Universe r is the gravitational radius r_G.

- The gravitational velocity v_G is the speed of light in a circular orbit wherein the eccentricity is equal to zero and the escape velocity from the Universe can never be reached.

- The period of the oscillation of the Universe and the period for light to transverse the Universe corresponding to the gravitational radius r_G must be equal.

The Period of Oscillation Based on Closed Propagation of Light cont'd

- The harmonic oscillation period, T, is

$$T = \frac{2\pi r_G}{c} = \frac{2\pi G m_U}{c^3} = \frac{2\pi G\left(2\ X\ 10^{54}\ kg\right)}{c^3} = 3.10\ X\ 10^{19}\ \sec\ = 9.83\ X\ 10^{11}\ years$$

  where the mass of the Universe, m_U, is approximately $2\ X\ 10^{54}\ kg$ (The initial mass of the Universe of $2\ X\ 10^{54}\ kg$ is based on internal consistency with the size, age, Hubble constant, temperature, density of matter, and power spectrum of the Universe.)

- Thus, the observed **Universe will expand as mass is released as photons for** $4.92\ X\ 10^{11}\ years$**. At this point in its world line, the Universe will obtain its maximum size and begin to contract**.

The Differential Equation of the Radius of the Universe

- Simple harmonic oscillator having a restoring force, $\mathbf{F}$, which is proportional to the radius.

- The proportionality constant, k, is given in terms of the potential energy, E, gained as the radius decreases from the maximum expansion to the minimum contraction.

$$\frac{E}{\aleph^2} = k$$

- The gravitational potential energy E_{grav}

$$E_{grav} = \frac{Gm_U^2}{r}$$

- Is equal to $m_U c^2$ when the radius of the Universe r is the gravitational radius r_G.

$$F = -k\aleph = -\frac{m_U c^2}{r_G^2}\aleph = -\frac{m_U c^2}{\left(\dfrac{Gm_U}{c^2}\right)^2}\aleph$$

The Differential Equation of the Radius of the Universe $\aleph$, Is

$$m_U \ddot{\aleph} + \frac{m_U c^2}{r_G^2} \aleph = 0$$

$$m_U \ddot{\aleph} + \frac{m_U c^2}{\left(\frac{G m_U}{c^2} \right)^2} \aleph = 0$$

The *Maximum Radius of the Universe*

The *Maximum Radius of the Universe*, the amplitude, r_0, of the time harmonic variation in the radius of the Universe, is given by the quotient of the total mass of the Universe m_U and the mass/energy to expansion/contraction quotient Q.

$$r_0 = \frac{m_U}{Q} = \frac{m_U}{\dfrac{c^3}{4\pi G}}$$

$$r_0 = \frac{2\ X\ 10^{54}\ kg}{\dfrac{c^3}{4\pi G}} = 1.97\ X\ 10^{12}\ light\ years$$

The *Minimum Radius*

The *Minimum Radius* corresponds to the gravitational radius

$$r_g = \frac{2Gm_U}{c^2}$$

$$r_g = \frac{2G\left(2\ X\ 10^{54}\ kg\right)}{c^2} = 3.12\ X\ 10^{11}\ light\ years$$

When the gravitational radius r_g *is the radius of the Universe, the proper time is equal to the coordinate time by*

$$\tau = ti\sqrt{\frac{2GM}{c^2 r_\alpha^*}} = ti\sqrt{\frac{2GM}{c^2 \lambda_c}} = ti\frac{v_g}{c}$$

And the gravitational escape velocity v_g *of the Universe is the speed of light.*

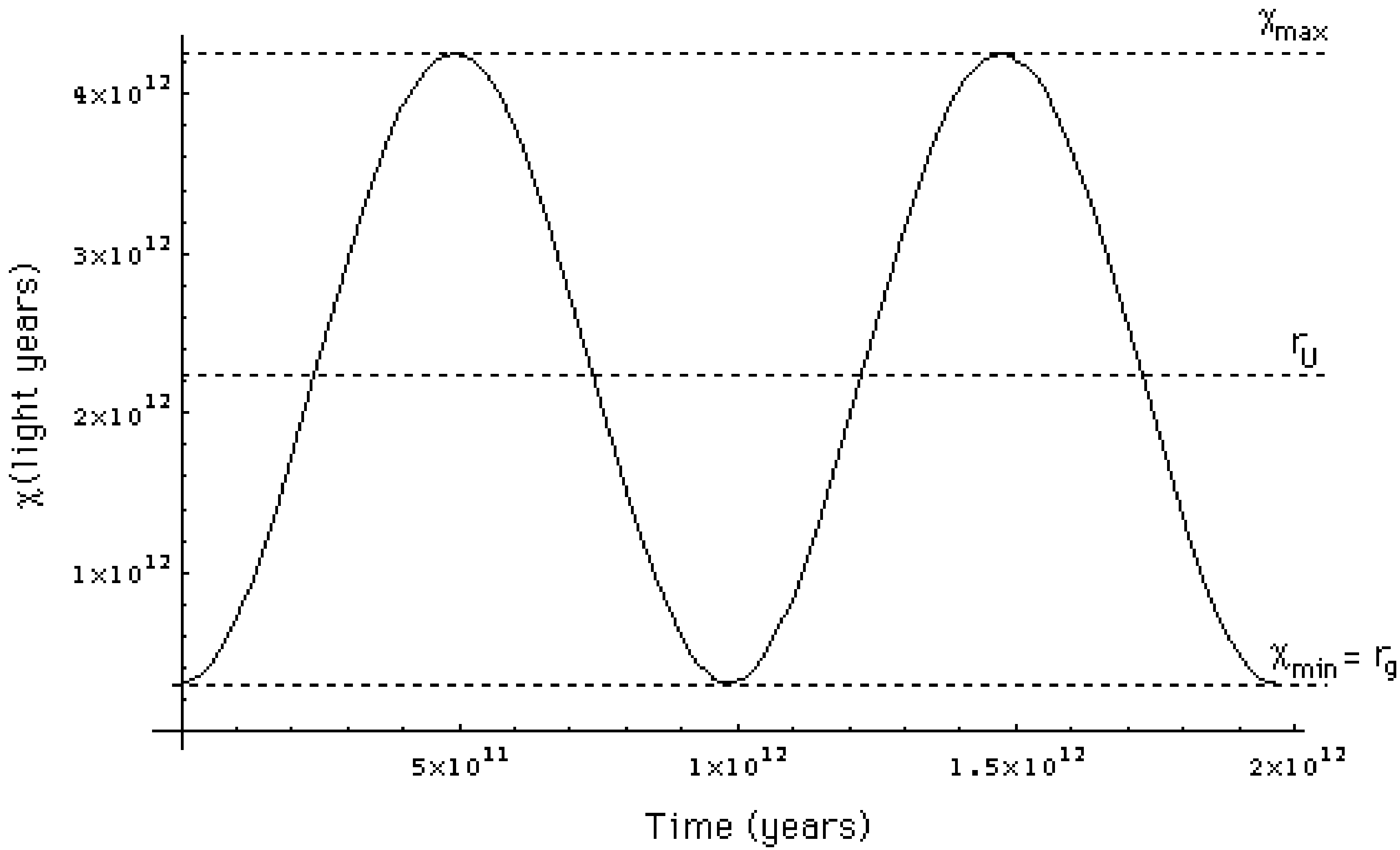
The Radius of the Universe As a Function of Time

$$\aleph = \left(r_g + \frac{cm_U}{Q} \right) - \frac{cm_U}{Q} \cos\left(\frac{2\pi t}{\frac{2\pi r_G}{c}} \right)$$

$$\aleph = \left(\frac{2Gm_U}{c^2} + \frac{cm_U}{\frac{c^3}{4\pi G}} \right) - \frac{cm_U}{\frac{c^3}{4\pi G}} \cos\left(\frac{2\pi t}{\frac{2\pi Gm_U}{c^3}} \right)$$

$$\aleph = 2.28\ X\ 10^{12} - 1.97\ X\ 10^{12} \cos\left(\frac{2\pi t}{9.83\ X\ 10^{11}\ yrs} \right) \textit{light years}$$

The Radius of the Universe as a Function of Time

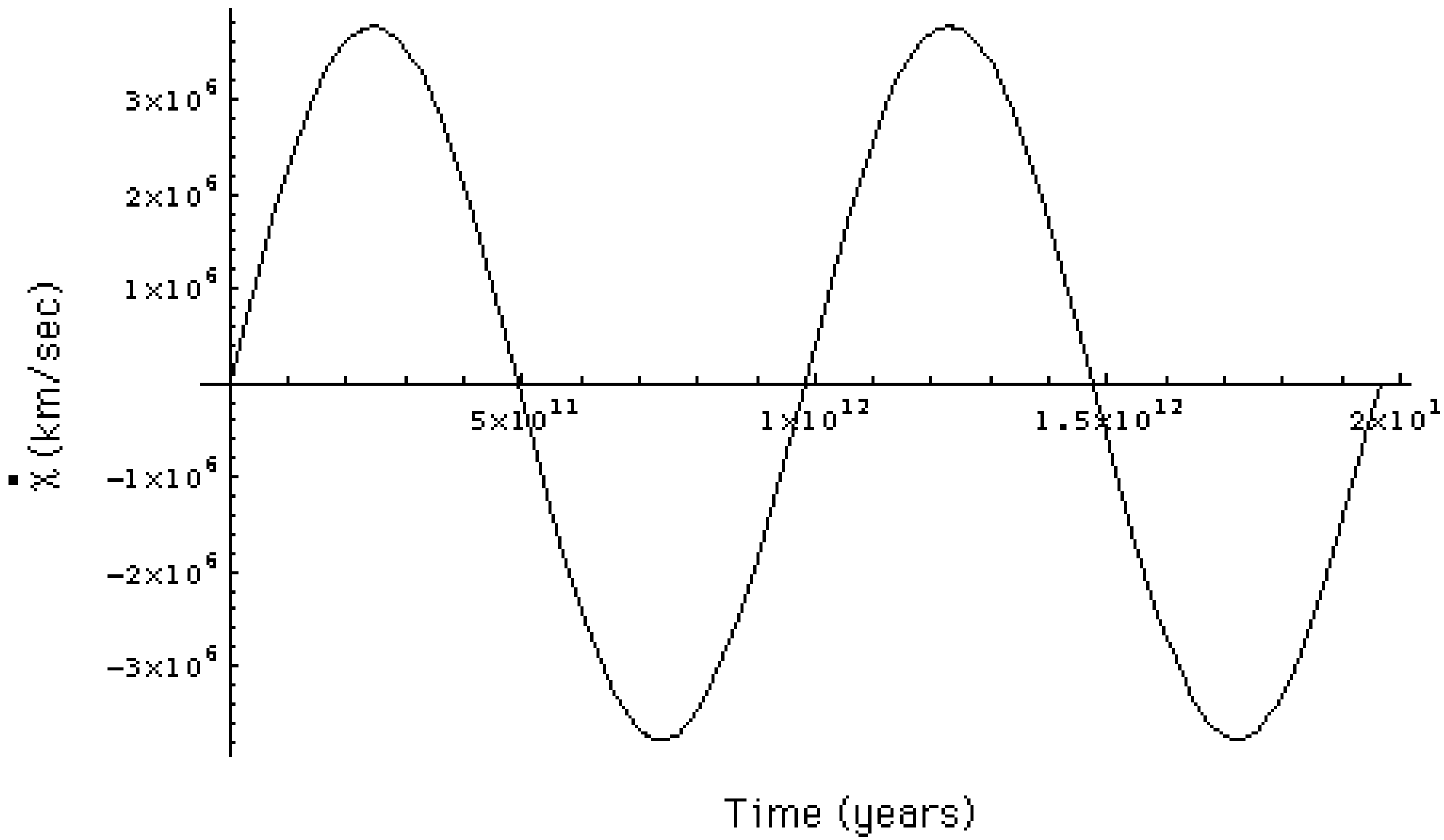


The Expansion/Contraction Rate, $\dot{\aleph}$

$$\dot{\aleph} = 4\pi c \, X \, 10^{-3} \sin\left(\frac{2\pi t}{\frac{2\pi G m_U}{c^3}} \right) \frac{\mathrm{k}m}{\sec}$$

$$\dot{\aleph} = 3.77 \, X \, 10^{6} \sin\left(\frac{2\pi t}{9.83 \, X \, 10^{11} \; yrs} \right) \frac{km}{\sec}$$

The Expansion/Contraction Rate of the Universe As a Function of Time



The Hubble Constant

The ***Hubble Constant*** is given by the ratio of the expansion rate given in units of $\frac{\mathrm{km}}{\mathrm{sec}}$ divided by the radius of the expansion in Mpc. The radius of expansion is equivalent to the radius of the light sphere with an origin at the time point when the Universe stopped contracting and started to expand. The radius is the time of expansion $ct(Mpc)$.

$$H = \frac{\dot{\aleph}}{ct} = \frac{4\pi c \times 10^{-3} \sin\left(\dfrac{2\pi t}{\dfrac{2\pi G m_U}{c^3}} \right) \dfrac{\mathrm{km}}{\mathrm{sec}}}{ct(Mpc)}$$

$$H = \frac{\dot{\aleph}}{ct} = \frac{3.77 \times 10^{6} \sin\left(\dfrac{2\pi t}{9.83 \times 10^{11}\,\mathrm{yrs}} \right) \dfrac{\mathrm{km}}{\mathrm{sec}}}{ct\,(Mpc)}$$

The Hubble Constant cont'd

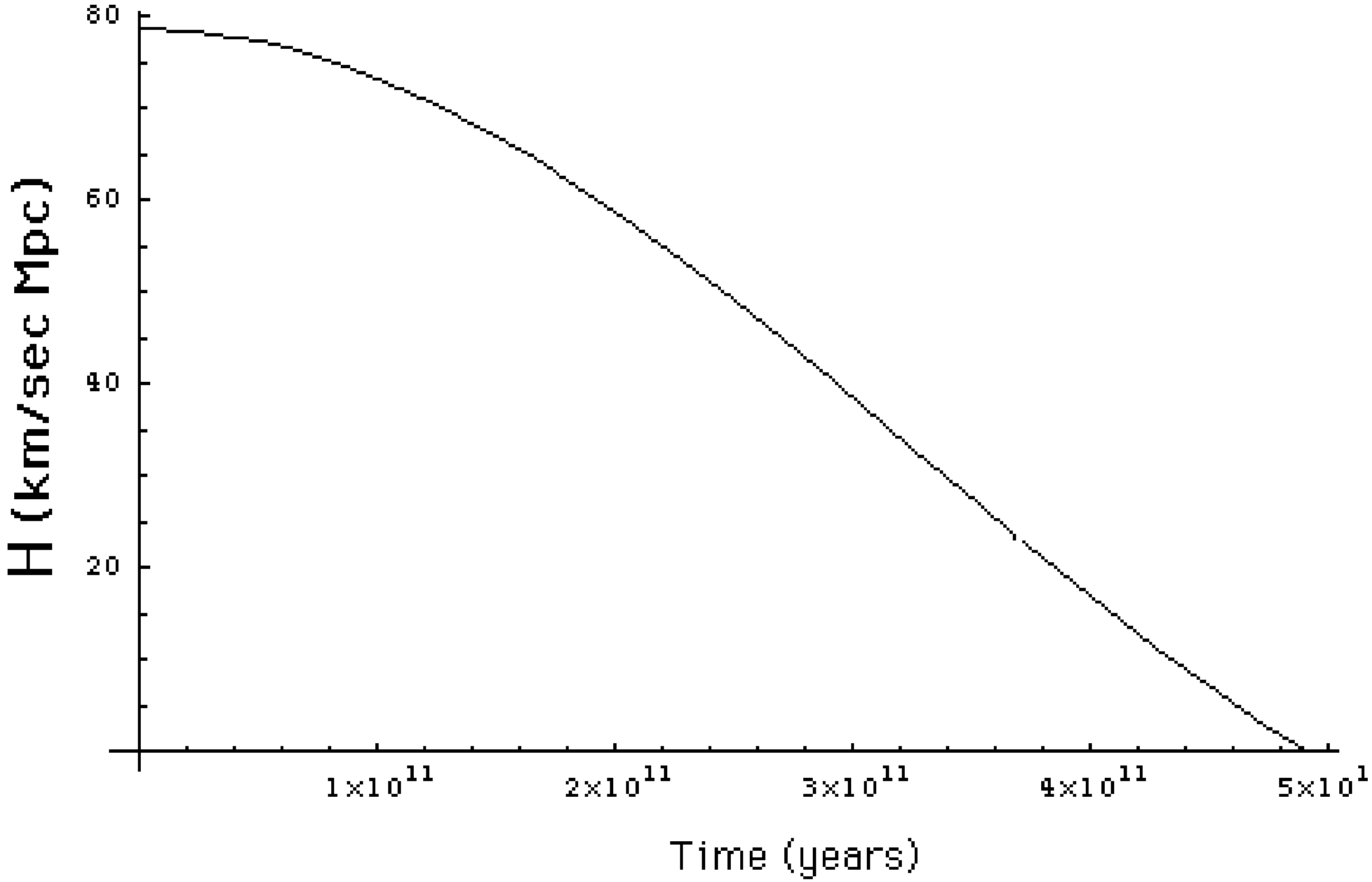
For $t = 10^{10}$ *light years*; $ct = 3.069 \times 10^{3}\, Mpc$, the Hubble, H_0, constant is

$$H_0 = 78.6 \frac{\text{km}}{\text{sec} \cdot Mpc}.$$

The experimental value is

$$H_0 = 80 \pm 17 \frac{\text{km}}{\text{sec} \cdot Mpc}.$$

The Hubble Constant of the Universe As a Function of Time



The Density of the Universe As a Function of Time

- The density of the Universe as a function of time $\rho_U(t)$ is given by the ratio of the mass as a function of time and the volume as a function of time.

$$\rho_U(t) = \frac{m_U(t)}{V(t)} = \frac{m_U(t)}{\frac{4}{3}\pi\aleph(t)^3} = \frac{\frac{m_U}{2}\left(1+\cos\left(\frac{2\pi t}{\frac{2\pi G m_U}{c^3}}\right)\right)}{\frac{4}{3}\pi\left(\left(\frac{2Gm_U}{c^2}+\frac{\frac{cm_U}{c^3}}{4\pi G}\right)-\frac{\frac{cm_U}{c^3}}{4\pi G}\cos\left(\frac{2\pi t}{\frac{2\pi G m_U}{c^3}}\right)\right)^3}$$

$$\rho_U(t) = \frac{1\,X\,10^{57}\left(1+\cos\left(\frac{2\pi t}{9.83\,X\,10^{11}\ yrs}\right)\right)g}{\frac{4}{3}\pi\left(2.16\,X\,10^{30}-1.86\,X\,10^{30}\cos\left(\frac{2\pi t}{9.83\,X\,10^{11}\ yrs}\right)cm\right)^3}$$

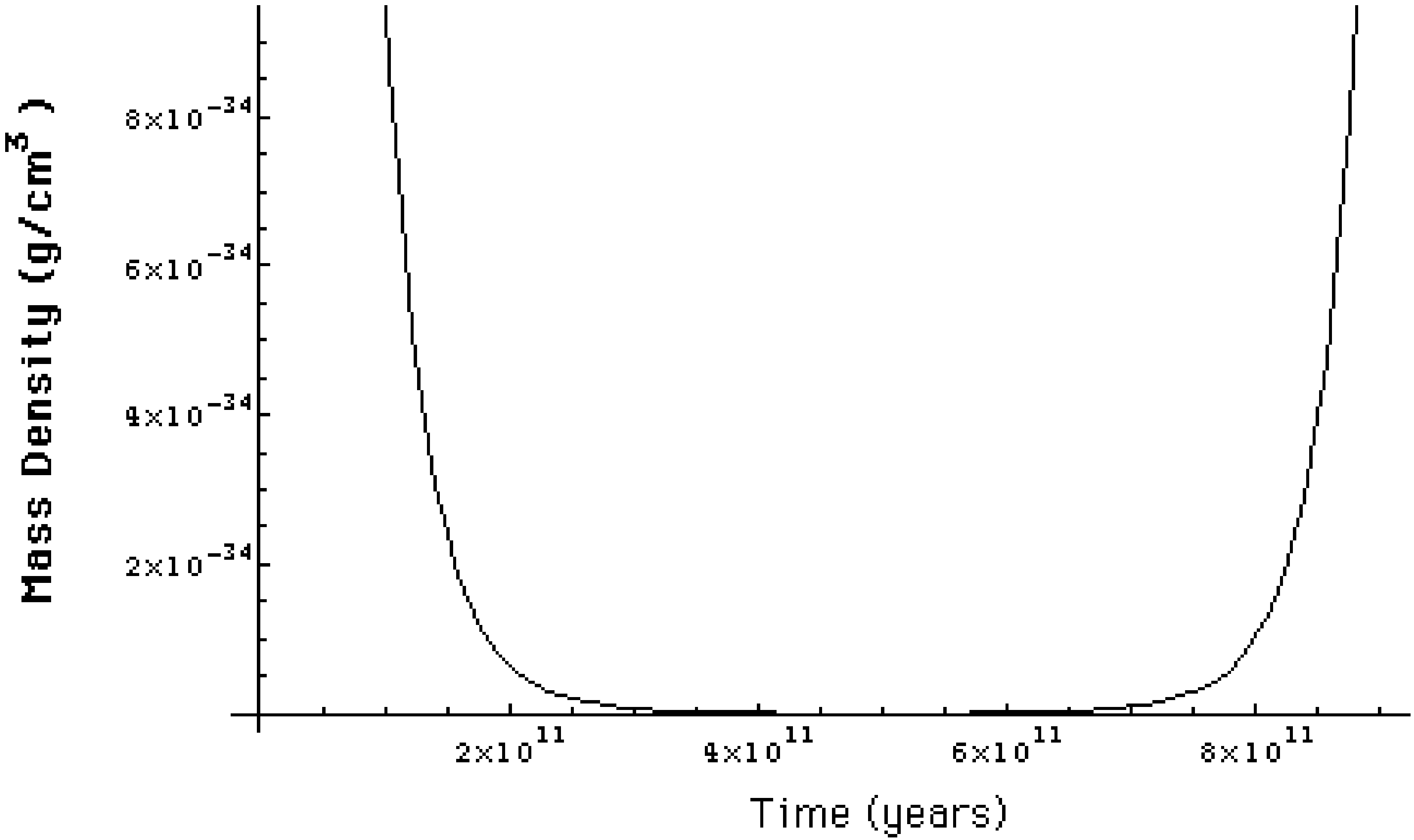
- For $t = 10^{10}\ light\ years = 3.069\,X\,10^3\,Mpc$

$$\rho_U = 1.7\,X\,10^{-32}\ g/cm^3$$

- The density of luminous matter of stars and gas of galaxies is about

$$\rho_U = 2\,X\,10^{-31}\ g/cm^3$$

The Density of the Universe As a Function of Time



The Power of the Universe As a Function of Time, $P_U(t)$

$$P_U(t) = \frac{c^5}{8\pi G}\left(1 + \cos\left(\frac{2\pi t}{\frac{2\pi r_G}{c}}\right)\right)$$

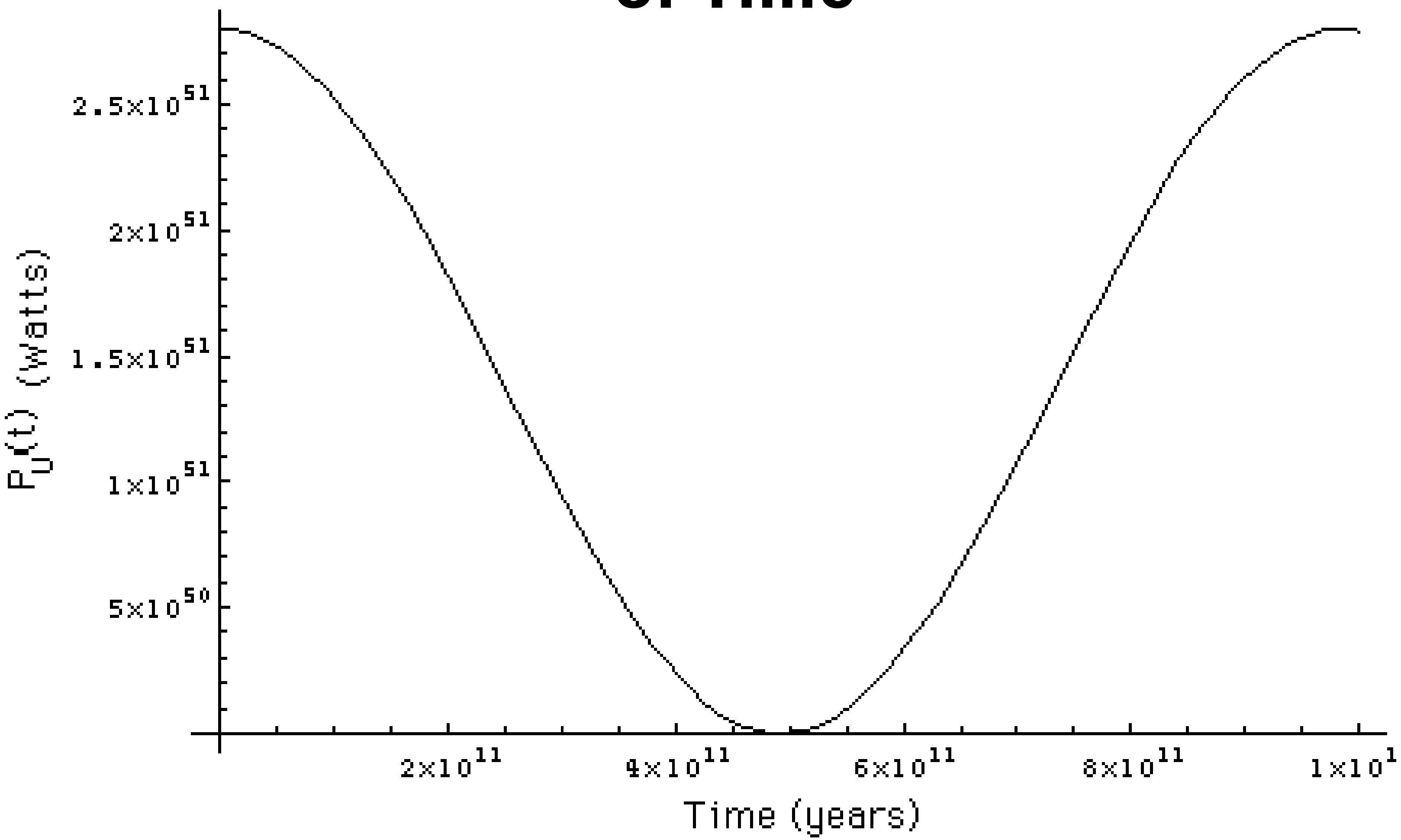
$$P_U(t) = 1.45\ X\ 10^{51}\left(1 + \cos\left(\frac{2\pi t}{9.83\ X\ 10^{11}\ \text{yrs}}\right)\right) W$$

For $t = 10^{10}\ light\ years$

$$P_U(t) = 2.88\ X\ 10^{51}\ W$$

The observed power is consistent with that predicted.

The Power of the Universe As a Function of Time



The Temperature of the Universe as a Function of Time Follows from the Stefan-Boltzman Law

$$T_U(t)=\left(\frac{1}{1+\dfrac{Gm_U(t)}{c^2\aleph(t)}}\right)\left[\frac{R_U(t)}{e\sigma}\right]^{\frac{1}{4}}=\left(\frac{1}{1+\dfrac{Gm_U(t)}{c^2\aleph(t)}}\right)\left[\frac{\dfrac{P_U(t)}{4\pi\aleph(t)^2}}{e\sigma}\right]^{\frac{1}{4}}$$

$$T_U(t)=\left(\frac{1}{1+\dfrac{\dfrac{Gm_U}{2}\left(1+\cos\left(\dfrac{2\pi t}{\frac{2\pi Gm_U}{c^3}}\right)\right)}{c^2\left(\left(\dfrac{2Gm_U}{c^2}+\dfrac{cm_U}{\frac{c^3}{4\pi G}}\right)-\dfrac{cm_U}{\frac{c^3}{4\pi G}}\cos\left(\dfrac{2\pi t}{\frac{2\pi Gm_U}{c^3}}\right)\right)}}\right)X$$

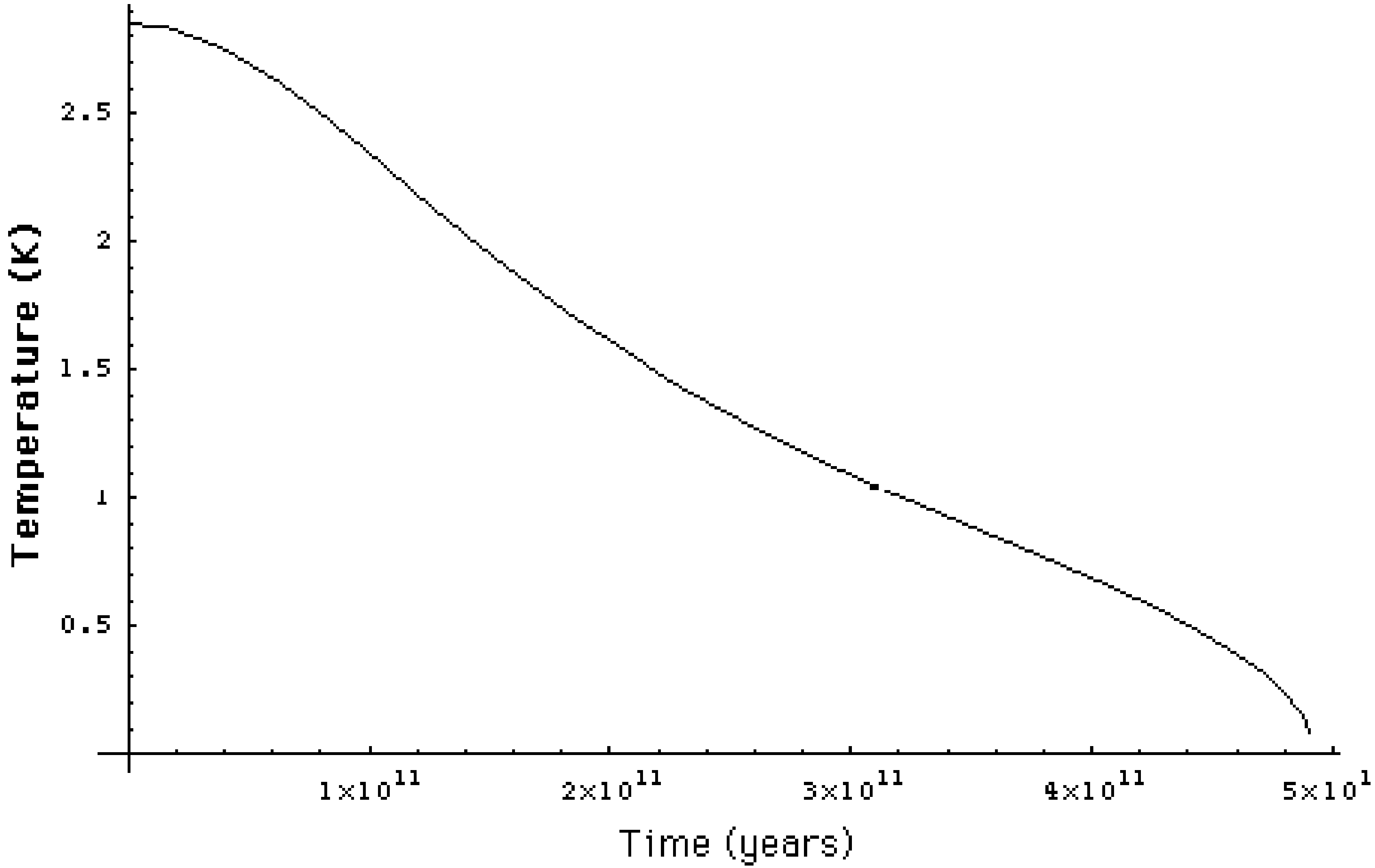
$$\left[\frac{\dfrac{\dfrac{c^5}{8\pi G}\left(1+\cos\left(\dfrac{2\pi t}{\frac{2\pi r_G}{c}}\right)\right)}{4\pi\left(\left(\dfrac{2Gm_U}{c^2}+\dfrac{cm_U}{\frac{c^3}{4\pi G}}\right)-\dfrac{cm_U}{\frac{c^3}{4\pi G}}\cos\left(\dfrac{2\pi t}{\frac{2\pi Gm_U}{c^3}}\right)\right)^2}}{e\sigma}\right]^{\frac{1}{4}}$$

The Temperature of the Universe As a Function of Time – cont'd

$$T_U(t) = \left(\frac{1}{1 + \dfrac{0.74\ X\ 10^{27}\left(1+\cos\left(\dfrac{2\pi t}{9.83\ X\ 10^{11}\ yrs}\right)\right)m}{\left[2.16\ X\ 10^{28} - 1.86\ X\ 10^{28}\cos\left(\dfrac{2\pi t}{9.83\ X\ 10^{11}\ yrs}\right)m\right]}} \right) X$$

$$\left[\frac{\dfrac{1.45\ X\ 10^{51}\left(1+\cos\left(\dfrac{2\pi t}{9.83\ X\ 10^{11}\ yrs}\right)\right)W}{4\pi\left[2.16\ X\ 10^{28} - 1.86\ X\ 10^{28}\cos\left(\dfrac{2\pi t}{9.83\ X\ 10^{11}\ yrs}\right)m\right]^2}}{5.67\,X\,10^{-8}\,Wm^{-2}K^{-4}} \right]^{\frac{1}{4}}$$

The Temperature of the Universe As a Function of Time During the Expansion Phase



The Expansion / Contraction Acceleration, $\ddot{\aleph}$

$$\ddot{\aleph} = 2\pi \frac{c^4}{Gm_U} \cos\left(\frac{2\pi t}{\frac{2\pi G m_U}{c^3} \ \sec} \right)$$

$$\ddot{\aleph} = H_o = 78.7 \cos\left(\frac{2\pi t}{3.01 \ X \ 10^5 \ Mpc} \right) \frac{km}{\sec \cdot Mpc}$$

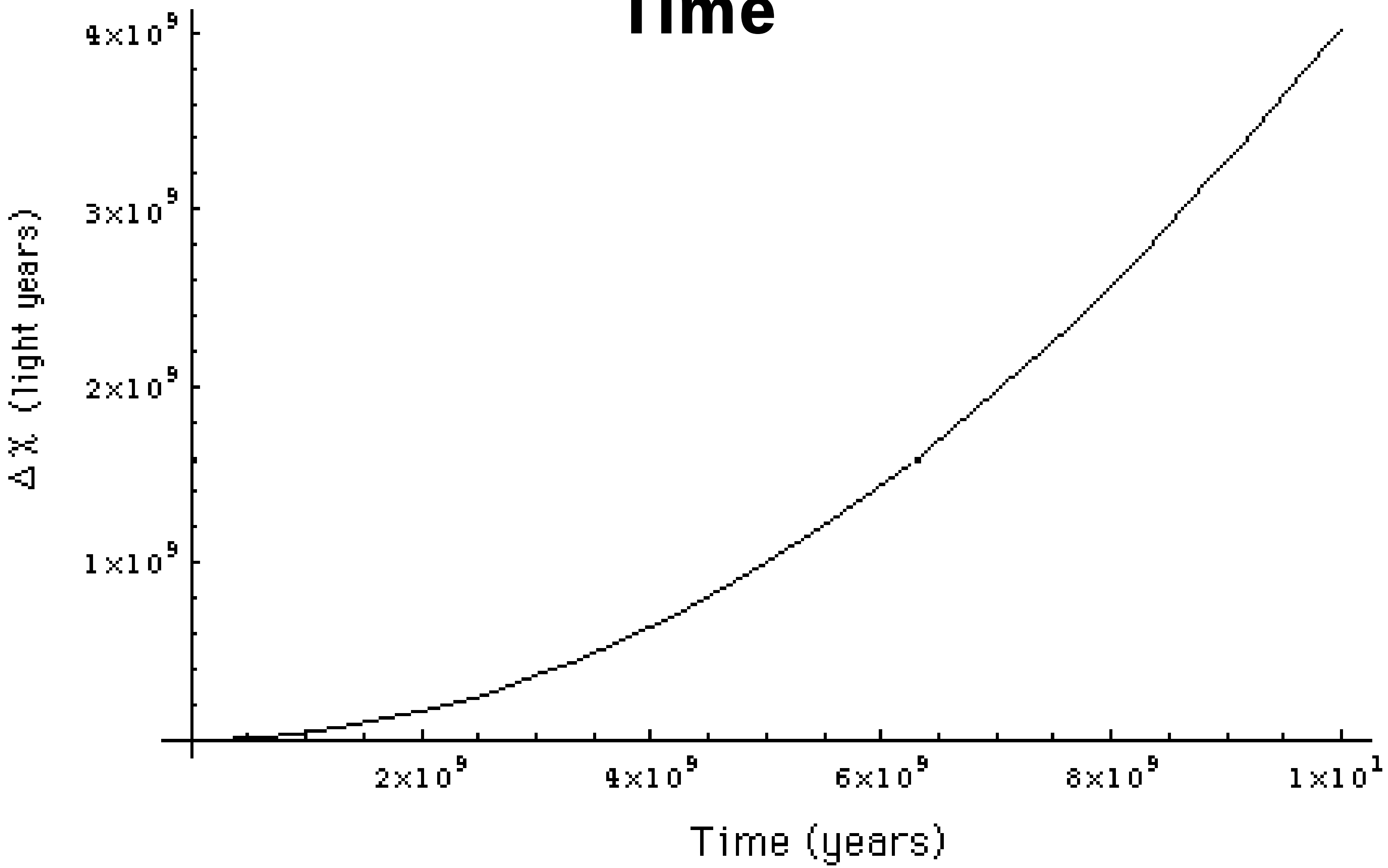
•The differential in the radius of the Universe $\Delta\aleph$ due to its acceleration is given by

$$\Delta\aleph = 1/2 \ddot{\aleph} t^2$$

• The differential in expanded radius for the elapsed time of expansion, $t = 10^{10} \ light \ years = 3.069 \ X \ 10^3 Mpc$ corresponds to a decease in brightness of a supernovae standard candle of about an order of magnitude of that expected where the distance is taken as $\Delta\aleph$. This result based on **the predicted rate of acceleration of the expansion is consistent with the experimental observation**

• The **microwave background radiation image** obtained by the **BOOMERANG telescope** was consistent with a Universe of nearly flat geometry since the commencement of its expansion. **The data is consistent with a large offset radius of the Universe with a fractional increase in size since the commencement of expansion about 10 billion years ago.**

The Differential Expansion of the Light Sphere Due to the Acceleration of the Expansion of the Cosmos As a Function of Time



Power Spectrum of the Cosmic Microwave Background Radiation (CMBR)

The cosmic microwave background radiation (CMBR) corresponds to an average temperature of 2.725 K, with deviations of 30 μK or so in different parts of the sky representing slight variations in the density of matter.

The Universe is a 3-sphere hyperspace of constant positive curvature that expands and contracts cyclically in all directions relative to an embedded space-time observer at his r-sphere.

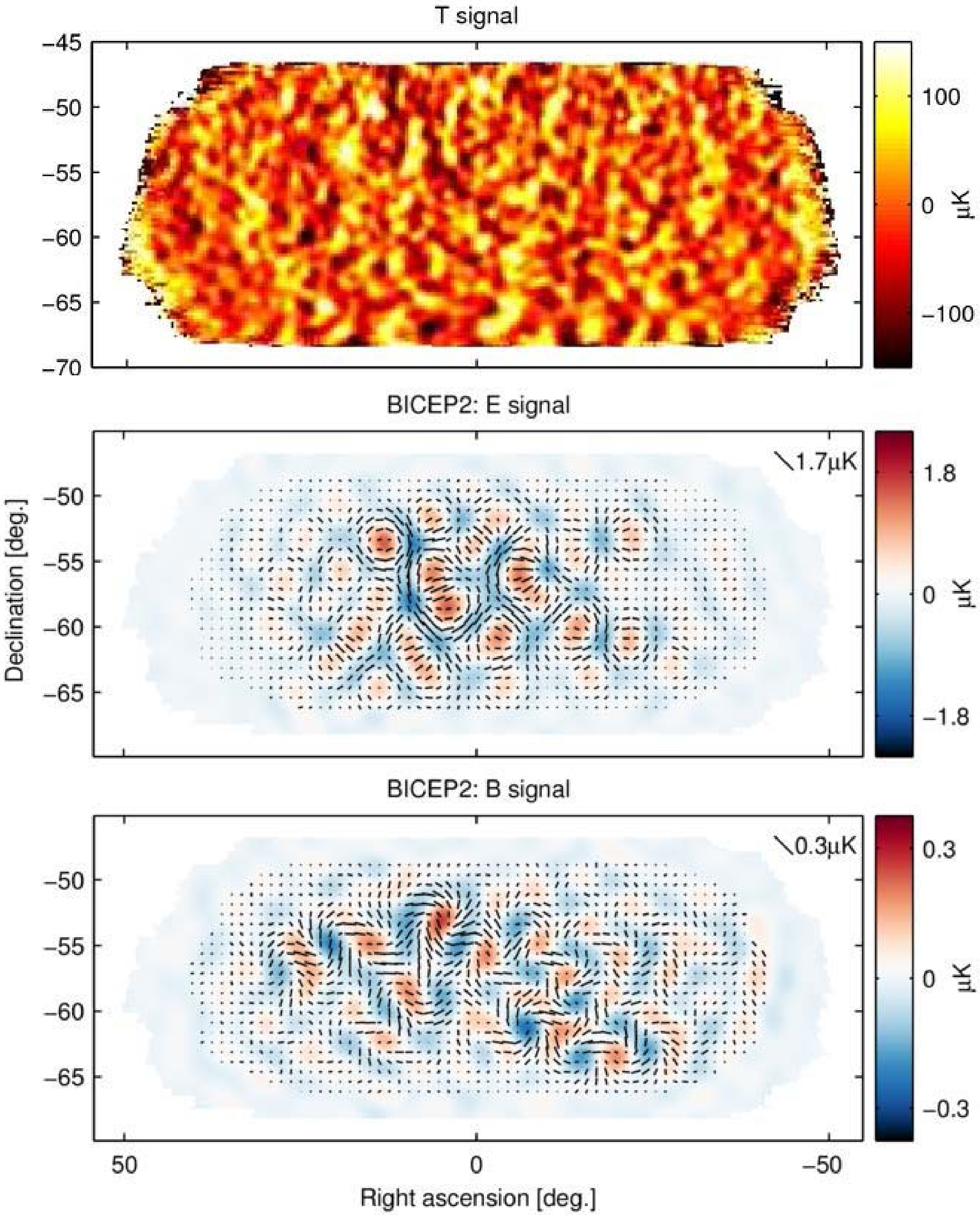
The harmonic oscillation of the radius of the Universe and thus its volume gives rise to delays and advances to light spheres of the continuum of r-spheres of the Universe.

The gravitational field fronts from particle production would otherwise propagate at relative velocity c.

However, as the radius of the initially entirely uniform radiation-filled Universe decreases gravity fronts are advanced or delayed as the distance between r-spheres changes such that constructive interference of fronts occur.

The resulting slight variations in the density of matter are observed from our present r-sphere as spherical harmonics corresponding to the spherical contraction and expansion in all directions.

For each r-sphere, the angular variation in density corresponds to an angular distribution of the power of the Universe and thus the temperature of the Universe according to the Stefan-Boltzmann law.



CMBR Continued

Color scale temperature variations and temperature variations of the E-mode and B-mode polarization of the CMBR of the Universe in degrees μK .

Courtesy of NASA, G. Hinshaw, *et al*.

CMBR Continued

The temperature variation ΔT is given by the spacetime Fourier transform of $T_U(t)$ in three dimensions in spherical coordinates plus time over the oscillatory period starting at matter formation at the initial time of contraction through the initiation of expansion to the present time in the expansion cycle, $r_{sphere} = 14.02\ X\ 10^9\ light\ years$.

$$\Delta T(s,\Theta,\Phi,\omega) =$$

$$C_{Tsphere}\int_0^{\infty}\int_0^{2\pi}\int_0^{\pi}\int_0^{\infty}\left[\begin{array}{l} T_U(t)\dfrac{1}{r_{sphere}^2}\delta(r-r_{sphere}) \\ \exp\left(\begin{array}{l}-i2\pi sr[\cos\Theta\cos\theta \\ +\sin\Theta\sin\theta\cos(\phi-\Phi)]\end{array}\right)\exp(-i\omega t)\end{array}\right] r^2\sin\theta dr d\theta d\phi dt$$

$$= 77\operatorname{sinc}\left(\frac{\pi}{140}(\ell-\ell_0)\right)\ \mu K$$

$$= 77\operatorname{sinc}\left(\frac{\pi}{140}(\ell-197)\right)\ \mu K$$

$\ell > 0$, Fourier wavenumber s is the multipole moment $\ell = \dfrac{2\pi}{\theta}$, $\dfrac{\pi}{\ell_{sphere}}$ is substituted for r_{sphere}, $\ell_{sphere} = 140$ is $\aleph_o / r_{sphere}$, $C_{Tsphere} = \left(\dfrac{ct}{\aleph_0}\right)^{-2} = (197)^{-2}$, the phase shift due relative position of r_{sphere} to $\aleph_o$ is $\ell_0 = \dfrac{\aleph_0}{ct} = 197$.

CMBR Continued

Polarized light is produced by Thompson scattering of the CMBR by stellar and interstellar medium plasma electrons (essentially ionized hydrogen) over the half period of contraction $T_U / 2 = 4.92 \ X \ 10^{11} \ y\text{ears}$ plus the time of expansion $t = 10^{10} \ years$. The phase shift corresponds to an opposite sign of the shift

$$\Delta T_{\text{E-mode}}(\ell) = C_{eff\text{Thompson}} 77\text{sinc}\left(\frac{\pi}{140}(\ell + 197)\right) \ \mu K$$

$\ell > 0$ and C_{eff} is the Thompson polarization constant.

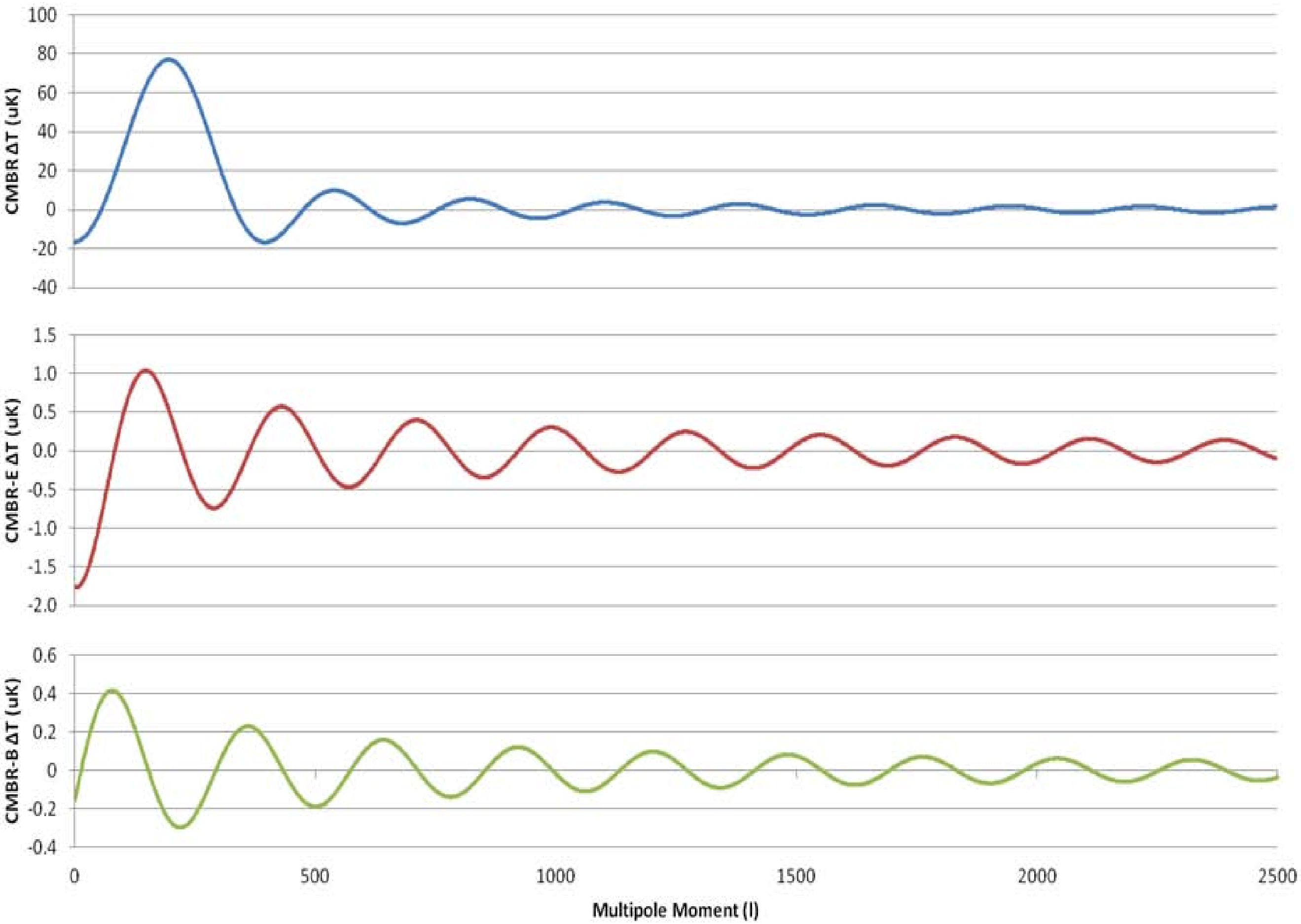
While propagating through accelerating expansion of spacetime, E-mode light experiences the same spacetime gradients as in the case of gravitational lensing; consequently, E-mode is converted to B-mode polarization. The B-mode radiation is shifted by $\dfrac{\pi}{2}$ relative to the E-mode radiation:

$$\Delta T_{\text{B-mode}}(\ell) = r^{1/2} C_{\text{effThompson}} 77\text{sinc}\left(\frac{\pi}{140}(\ell + 197 + 70)\right) \ \mu K$$

$$\ell > 0 \ , \quad r^{1/2} = \frac{\Delta T\left(B\text{ - mode}\right)}{\Delta T\left(E\text{ - mode}\right)} = \frac{\Delta \aleph = 1/2\ddot{\aleph} t^2}{(ct)} = \left(\frac{4.02 \ X \ 10^9 \ \ light \ years}{10^{10} \ \ light \ years}\right) = 0.40$$

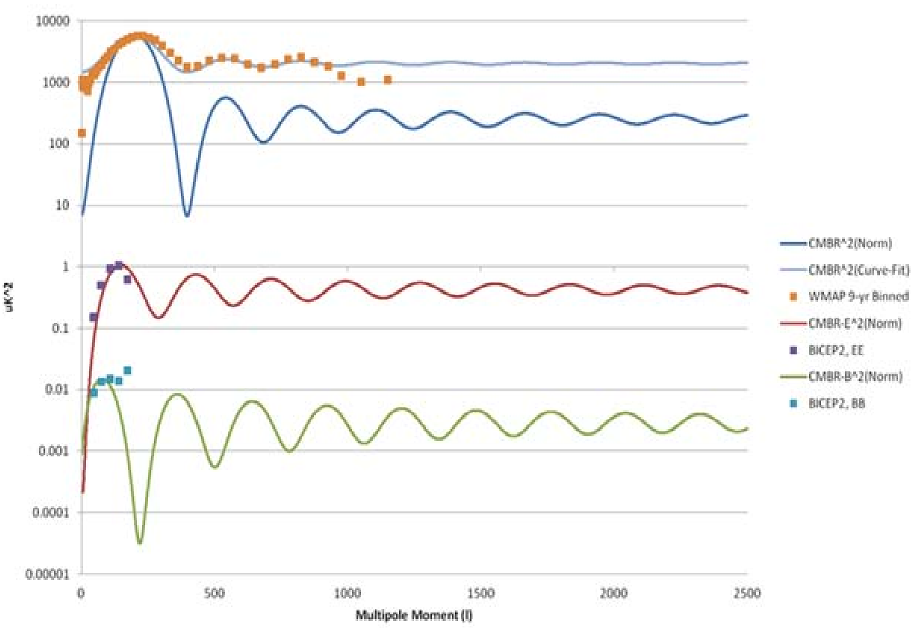
CMBR Continued

The temperature variations and temperature variations of the E-mode and B-mode polarization of the CMBR of the Universe in degrees μK as a function of multipole moment ℓ .

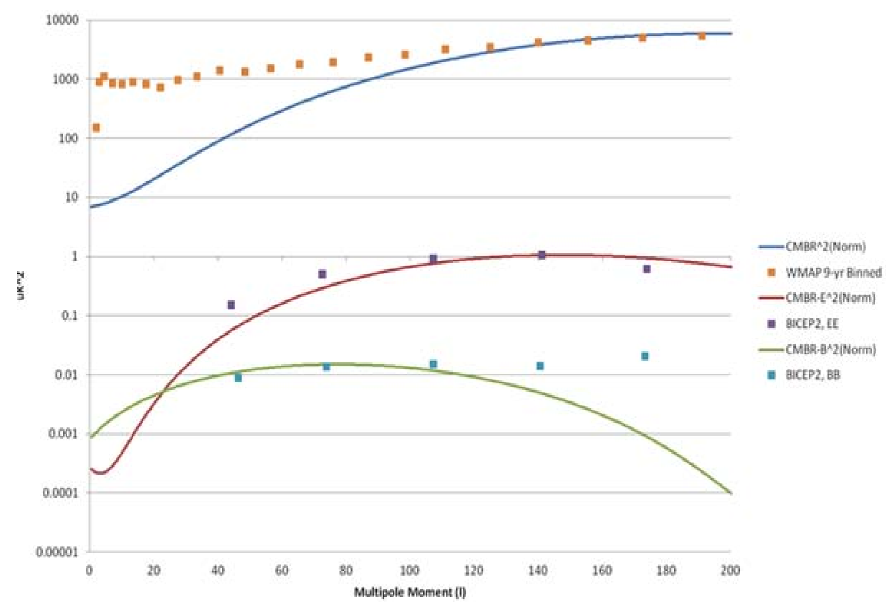


CMBR Continued

The power spectrum comprising spherical harmonic coefficient $\dfrac{\ell(\ell+1)C_\ell}{2\pi}\left[\mu K^2\right]$ amplitudes as a function of multipole ℓ for the temperature variations and temperature variations of the E-mode and B-mode polarization of the CMBR of the Universe. The experimental data points of BICEP2 for the E-mode peak at $\ell = 140$ and then the B-mode peak as $\ell = 70$, $r = 0.20^{+0.07}_{-0.05}$ are superimposed. A. Plot over the range $0 \le \ell \le 2500$. B. Plot over the range $0 \le \ell \le 200$.



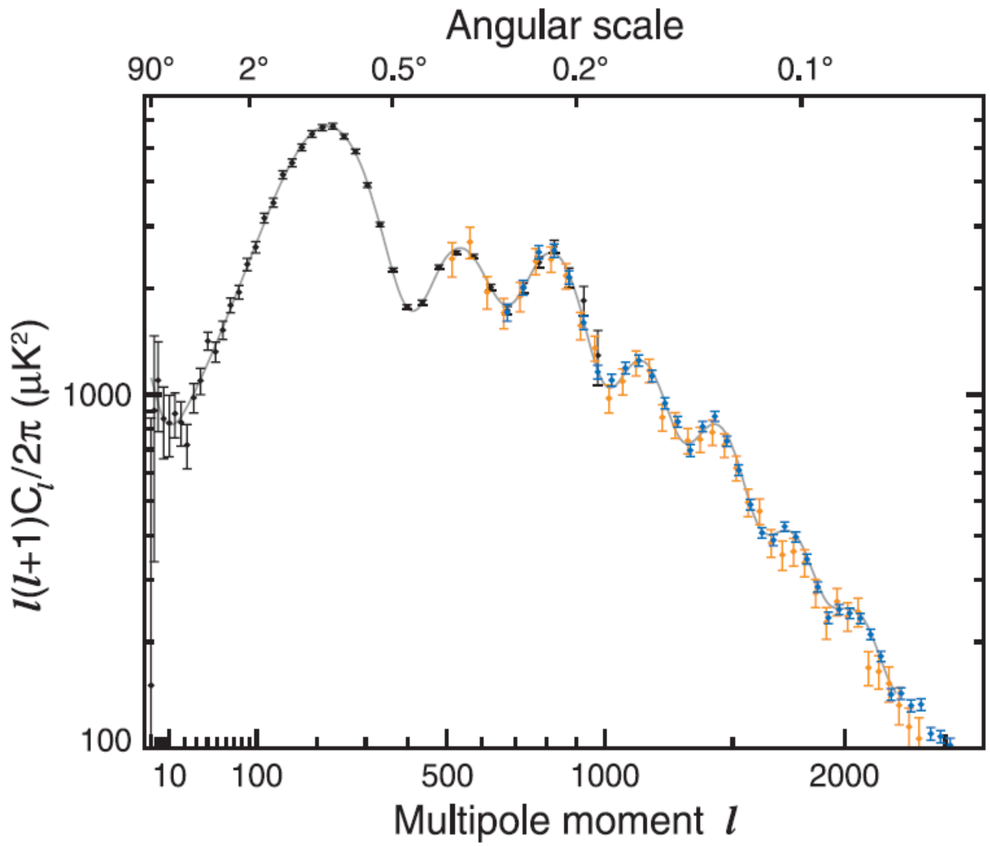
(A)



(B)

CMBR Continued

The experimental power spectrum of WMAP with the data of SPT and ACT and best curve fit comprising spherical harmonic coefficient $\frac{\ell(\ell+1)C_\ell}{2\pi}\left[\mu K^2\right]$ amplitudes as a function of multipole ℓ for the temperature variations of the CMBR of the Universe. Courtesy of NASA, G. Hinshaw, *et al*.



The Periods of Spacetime Expansion/Contraction and Particle Decay/Production for the Universe Are Equal

- The period of the expansion/contraction cycle of the radius of the Universe, T , is

$$T = \frac{2\pi G m_U}{c^3} \text{ sec}$$

- It follows from the Poynting power theorem with spherical radiation that the transition lifetimes are given by the ratio of energy and the power of the transition.

$$\tau = \frac{energy}{power} = \frac{[\hbar\omega]}{\left[\frac{2\pi c}{[(2l+1)!!]^2}\left(\frac{l+1}{l}\right)k^{2l+1}\left|Q_{lm} + Q'_{lm}\right|^2\right]} = \frac{1}{2\pi}\left(\frac{h}{e^2}\right)\sqrt{\frac{\varepsilon_0}{\mu_0}}\frac{[(2l+1)!!]^2}{2\pi}\left(\frac{l}{l+1}\right)\left(\frac{l+3}{3}\right)^2\frac{1}{(kr_n)^{2l}\omega}$$

- Exponential decay applies to electromagnetic energy decay.

$$h(t) = e^{-\alpha t}u(t) = e^{-\frac{2\pi}{T}t}u(t)$$

The Coordinate Time Is Imaginary Because Energy Transitions Are Spacelike Due to Spacetime Expansion From Matter to Energy Conversion

- For example, the mass of the electron (a fundamental particle) is given by

$$\frac{2\pi \lambdabar_C}{\sqrt{\frac{2Gm_e}{\lambdabar_C}}} = \frac{2\pi \lambdabar_C}{v_g} = i\alpha^{-1}\,\mathrm{sec}$$

where v_g is Newtonian gravitational velocity.

- When the gravitational radius r_g is the radius of the Universe, the proper time is equal to the coordinate time by

$$\tau = ti\sqrt{\frac{2GM}{c^2 r_\alpha^*}} = ti\sqrt{\frac{2GM}{c^2 \lambdabar_C}} = ti\frac{v_g}{c}$$

and the gravitational escape velocity v_g of the Universe is the speed of light.

- Replacement of the coordinate time, t , by the spacelike time, it , gives

$$h(t) = \mathrm{Re}\left\{ e^{-i2\pi\frac{1}{T}t} \right\} = \cos\frac{2\pi}{T}t$$

where the period is T.

Period Equivalents

The periods of spacetime expansion / contraction and particle decay / production for the Universe are equal because only the particles which satisfy Maxwell's equations and the relationship between proper time and coordinate time imposed by the Schwarzschild metric may exist.

Continuity conditions based on the constant maximum speed of light **(Maxwell's equations)**

$$m_0c^2 = \hbar\omega^* = V = E_{mag} = E_{spacetime}$$

$$m_0c^2 = \hbar\omega^* = \frac{\hbar^2}{m_0\lambda_C^2} = \alpha^{-1}\frac{e^2}{4\pi\varepsilon_0\lambda_C} = \alpha^{-1}\frac{\pi\mu_0 e^2\hbar^2}{(2\pi m_0)^2\lambda_C^3} = \frac{\alpha h}{1\,\text{sec}}\sqrt{\frac{\lambda_C c^2}{2Gm}}$$

Continuity conditions based on the constant maximum speed of light **(Schwarzschild metric)**

$$\frac{\text{proper time}}{\text{coordinate time}} = \frac{\text{gravitational wave condition}}{\text{eletromagnetic wave condition}} = \frac{\text{gravitational mass phase matching}}{\text{charge/inertial mass phase matching}}$$

$$\frac{\text{proper time}}{\text{coordinate time}} = i\frac{\sqrt{\dfrac{2Gm}{c^2\lambda_C}}}{\alpha} = i\frac{v_g}{\alpha c}$$

Wave Equation

$$\frac{1}{c^2}\left(\frac{\partial^2\omega}{\partial t^2}\right)-\left(grad^2\omega\right)=0$$

The equation of the radius of the Universe, $\aleph$, may be written as

$$\aleph=\left(\frac{2Gm_U}{c^2}+\frac{\frac{cm_U}{c^3}}{4\pi G}\right)-\frac{\frac{cm_U}{c^3}}{4\pi G}\cos\left(\frac{2\pi}{\frac{2\pi Gm_U}{c^3}\sec}\left(t-\frac{\aleph}{c}\right)\right)m$$

which is a solution to the wave equation.

Conclusion

Maxwell’s equations, Planck’s equation, the de Broglie equation, Newton’s laws, and Special, and General Relativity are Unified.

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