

Beyond Higgs: Physics of the Massless Phase

Frank Dodd (Tony) Smith, Jr. - 2013

At Temperature / Energy above $3 \times 10^{15} \text{ K} = 300 \text{ GeV}$:
the Higgs mechanism is not in effect so there is full ElectroWeak Symmetry
and no particles have any mass from the Higgs.

Questions arise:

1 - Can we build a collider that will explore the Massless Phase ?

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2 - How did our Universe evolve in that early Massless Phase of its first $10^{(-11)}$ seconds or so ?

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3 - What do physical phenomena look like in the Massless Phase ?

A - ElectroWeak Particles behave more like Waves than Particles.

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B - Conformal Gravity Dark Energy whose GraviPhotons might be accessible to experiments using BSCCO Josephson Junctions.

I. E. Segal proposed a Minkowski-Conformal 2-phase Universe and

Beck and Mackey proposed 2 Photon-GraviPhoton phases:

Minkowski/Photon phase locally Minkowski with ordinary Photons and
weak Gravity.

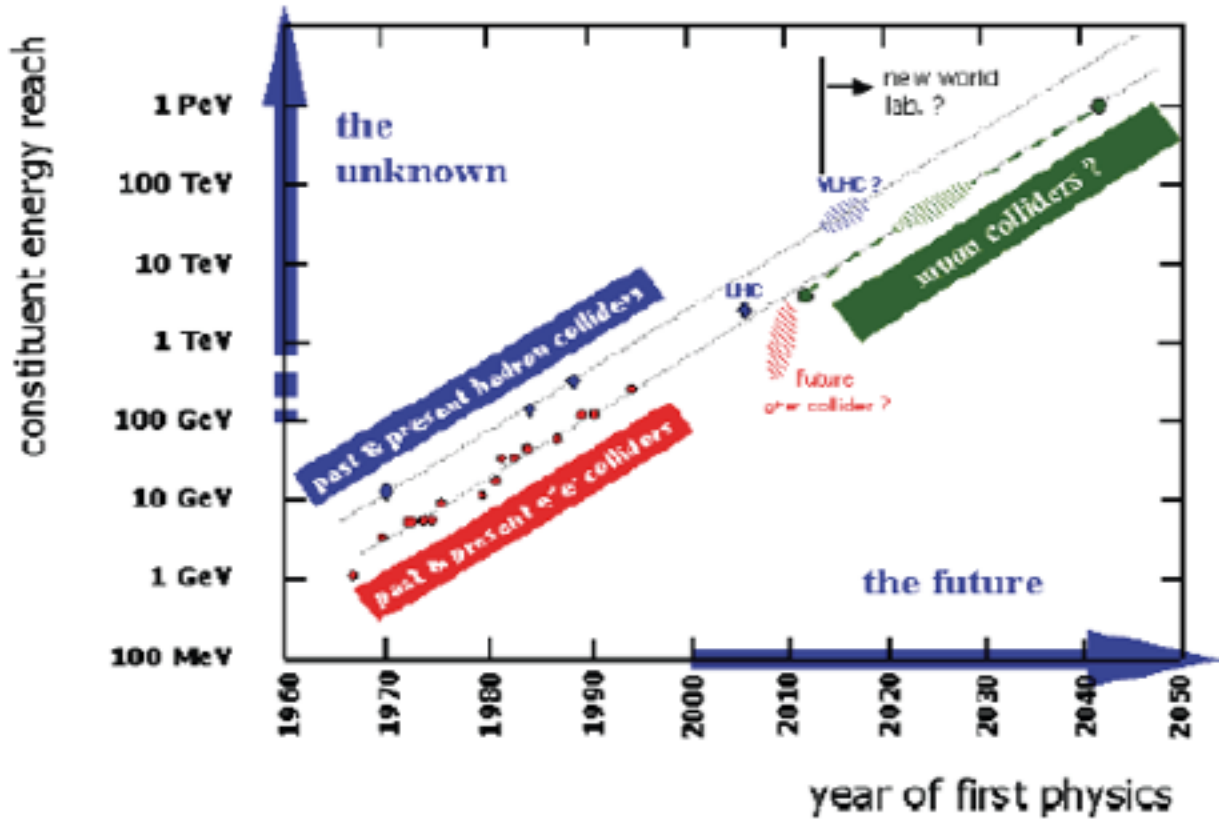
Conformal/GraviPhoton phase with GraviPhotons and

Conformal massless symmetry and consequently strong Gravity.

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1 - Can we build a collider that will explore the Massless Phase ?

Yes: In hep-ex00050008 Bruce King has a chart and he gives a cost estimate of



about \$12 billion for a 1000 TeV (1 PeV) Linear Muon Collider with tunnel length about 1000 km. Marc Sher has noted that by now (late 2012 / early 2013) the cost estimate of \$12 billion should be doubled or more. My view is that a cost of \$100 billion is easily affordable by the USA as it is far less than the Trillions given annually since 2008 by the USA Fed/Treasury to Big Banks as Quantitative Easing to support their Derivatives Casino.

Science will advance AND non-Bankster people will get paying jobs.

2 - How did our Universe evolve in that early Massless Phase of its first $10^{(-11)}$ seconds or so ?

In the context of E8 Physics as described at vixra 1108.0027 our Universe began as a Quantum Fluctuation from a Parent Universe whereby

our Universe initially had Planck Scale Temperature / Energy
 $10^{32} \text{ K} = 1.22 \times 10^{19} \text{ GeV}$.

Its physics was then described by a Lagrangian with:

Gauge Boson term of 28-dimensional adjoint Spin(8) that eventually produces 16-dim U(2,2) Conformal Gravity/Higgs and the 12-dim SU(3)xSU(2)xU(1) Standard Model;

Fermion term of 8-dimensional half-spinor Spin(8) corresponding to first-generation fermion particles and antiparticles (electron, RGB Up quarks; neutrino, RGB down quarks);

Base Manifold of 8-dimensional Octonionic Spacetime.

With respect to 8-dimensional Spacetime

the dimensionality of the Gauge Boson term is $28 \times 1 = 28$
and

the dimensionality of the Fermion term is $8 \times 7/2 = 28$

(see Weinberg's 1986 Dirac Memorial Lecture at page 88
and note that $7/2 + 7/2 + 1 = 8$)

so

the E8 Physics Lagrangian is clearly Ultraviolet Finite at the Planck Scale due to Triality-based cancellations, an effective Subtle Supersymmetry. Since the lower energy forms of E8 Physics are derived from the Planck Scale Lagrangian, they also benefit from the cancellations.

As Our Universe began to cool down below the Planck Scale

Inflationary Expansion started due to Octonionic Quantum Non-Unitarity

(see Adler's book "Quaternionic Quantum Mechanics ..." at pages 50-52 and 561).

Paola Zizzi describes the Octonionic Inflationary Era in terms of Clifford Algebras in gr-qc/0007006 and related papers. In short, the 64 doublings of Zizzi Inflation produce about 10^{77} fermion particles.

At the End of Inflation Our Universe had Temperature / Energy
 $10^{27} \text{ K} = 10^{14} \text{ GeV}$

A consequence of the end of Octonionic Inflation was the freezing out of a preferred Quaternionic Subspace so that 8-dim Octonionic Spacetime was converted into (4+4)-dim Kaluza-Klein spacetime $M4 \times CP2$ where $M4$ is Minkowski Physical 4-dim spacetime and $CP2 = SU(3) / SU(2) \times U(1)$ is a Batakis 4-dim Internal Symmetry Space. The geometry of that splitting of spacetime produces a Higgs mechanism. (see Meinhard Mayer and A. Trautman in "A Brief Introduction to the Geometry of Gauge Fields" and "The Geometry of Symmetry Breaking in Gauge Theories", Acta Physica Austriaca, Suppl. XXIII (1981))

Since each of the 10^{77} fermions had energy of 10^{14} GeV collisions among them would for each of the 10^{77} fermions produce jets containing about 10^{12} particles of energy 100 GeV or so so that the total number of such particles is about 10^{89} .

According to Weinberg's book "Cosmology":

"... above 10^{13} K , nucleons would not yet have formed from their three constituent quarks, and there would have been roughly as many quark-antiquark pairs in thermal equilibrium as photons ... before annihilation there must have been a slight excess ... of quarks over antiquarks, so that some quarks would survive to form nucleons when all the antiquarks had annihilated with quarks. There was also a slight excess of electrons over positrons, to maintain charge neutrality of the universe ...".

Therefore, in the interval

between **the End of Inflation** and **ElectroWeak Symmetry Breaking** most of the quarks in 10^{89} fermions formed quark-antiquark pairs that produced as a condensate the Higgs that is needed for Mayer-Higgs. The quark-antiquark condensate Higgs then

Breaks ElectroWeak Symmetry at Temperature / Energy
 $3 \times 10^{15} \text{ K} = 300 \text{ GeV}$

and gives mass to particles and at age $10^{-(11)}$ seconds
ends the Massless Phase of the history of Our Universe.

3 - What do physical phenomena look like in the Massless Phase ?

Two points of view are important:

ElectroWeak Particles and Dark Energy Conformal Gravity

ElectroWeak Particles:

The Weak Force Strength is $0.2535 \times (1 / MW^2) = 1.05 \times 10^{-5}$ where MW is a Weak Boson Mass factor that goes away in the Massless Realm where the Weak Force becomes a strong 0.25345.

As to Kobayashi-Maskawa Weak Force mixing in the Massless Realm, Kea (Marni Sheppard) proposed that in the Massless Realm the mixing matrix might be democratic which to me means that in the Massless Realm you might say that there is just a democratic mixing matrix of the form $1/3 \times$

$$\begin{matrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{matrix}$$

with no complex terms and no CP violation in the Massless Realm.

With no mass terms, the structure of particle interactions would be based on the Wave Picture instead of the Particle Picture. Instead of a particle with mass moving slower than light the picture is a massless particle moving at light speed with its energy defined by its frequency.

In that picture, for example, a Muon is distinguishable from an electron by higher frequency due to the 2-fold 4+4 path of second generation fermions instead of simple 4 path of first generation fermions.

Quark wave paths have $S7 \times RP1$ structure whose greater complexity produces higher frequency than Lepton wave paths.

Bound structures (Hadrons, Mesons, Nuclei, Atoms, etc) are based on standing wave frequencies instead of masses of particles, nuclei, etc.

Conformal Gravity Dark Energy:

I. E. Segal proposed a Minkowski-Conformal 2-phase Universe and

Beck and Mackey proposed 2 Photon-GraviPhoton phases:

Minkowski/Photon phase locally Minkowski with ordinary Photons and Gravity weakened by $1 / (M_{\text{Planck}})^2 = 5 \times 10^{(-39)}$.

so that we see Dark Energy as only 3.9 GeV/m^3

Conformal/GraviPhoton phase with GraviPhotons and Conformal symmetry (like the massless phase of energies above Higgs EW symmetry breaking) With massless Planck the $1 / M_{\text{Planck}}^2$ Gravity weakening goes away and the Gravity Force Strength becomes the strongest possible = 1 so Conformal Gravity Dark Energy should be enhanced by M_{Planck}^2 from the Minkowski/Photon phase value of 3.9 GeV/m^3 .

The Energy Gap of our Universe as superconductor condensate spacetime is from

from $3 \times 10^{(-18)} \text{ Hz}$ (radius of universe) to $3 \times 10^{43} \text{ Hz}$ (Planck length) and

its RMS amplitude is $10^{13} \text{ Hz} = 10 \text{ THz} = \text{energy of neutrino masses} =$
 $= \text{critical temperature } T_c \text{ of BSCCO superconducting crystals.}$

Neutrino masses are involved because their mass is zero at tree level and their masses that we observe come from virtual graviphotons becoming virtual neutrino-antineutrino pairs.

BSCCO superconducting crystals are by their structure natural Josephson Junctions. Dark Energy accumulates (through graviphotons) in the superconducting layers of BSCCO.

Josephson Junction control voltage acts as a valve for access to the BSCCO Dark Energy.

In E8 Physics Dark Energy comes from the Conformal/GraviPhoton phase. The geometry of the Conformal Sector is closely related to the Penrose Paradise of Twistors. Yu. Manin in his 1981 book "Mathematics and Physics" said: "... In a world of light there are neither points nor moments of time; beings woven from light would live "nowhere" and "nowhen" ... the whole life history of a free photon [is] the smallest "event" that can happen to light. ...".

Here is how the Conformal/GraviPhoton phase of Gravity works:
The Lorentz Group is represented by 6 generators

$$\begin{array}{cccc}
 0 & J1 & J2 & M1 \\
 -J1 & 0 & J3 & M2 \\
 -J2 & -J3 & 0 & M3 \\
 -M1 & -M2 & -M3 & 0
 \end{array}$$

There are two ways to extend the Lorentz Group:

(see arXiv gr-qc/9809061 by Aldrovandi and Peireira):

to the Poincare Group of Minkowski Space with No Cosmological Constant of the Minkowski/Photon phase where ordinary Photons usually live by adding 4 generators

$$\begin{array}{cccccc}
 0 & J1 & J2 & M1 & & A1 \\
 -J1 & 0 & J3 & M2 & & A2 \\
 -J2 & -J3 & 0 & M3 & & A3 \\
 -M1 & -M2 & -M3 & 0 & & A4 \\
 \\
 -A1 & -A2 & -A3 & -A4 & & 0
 \end{array}$$

{A1,A2,A3} represent Momentum
and {A4} represents Energy/Mass of Poincare Gravity
and its Dark Matter Primordial Black Holes

and

to the semidirect product of Lorentz and 4 Special Conformal generators to get a Non-Zero Cosmological Constant for Universe Expansion of the Conformal/GraviPhoton phase where GraviPhotons usually live

0	J1	J2	M1	G1
-J1	0	J3	M2	G2
-J2	-J3	0	M3	G3
-M1	-M2	-M3	0	G4
-G1	-G2	-G3	-G4	0

so that {G1,G2,G3} represent 3 Higgs components giving mass to 3 Weak Bosons and {G4} represents massive Higgs Scalar as Fermion Condensate. As Special Conformal and Scale Conformal degrees of freedom they also represent the Momentum of Expansion of the Universe and Dark Energy.

One more generator {G5} represents Higgs mass of Ordinary Matter. All 15 generators combine to make the full Conformal Lie Algebra $SU(2,2) = Spin(2,4)$ of the universal Conformal Space with a Non-Zero Cosmological Constant for Universe Expansion

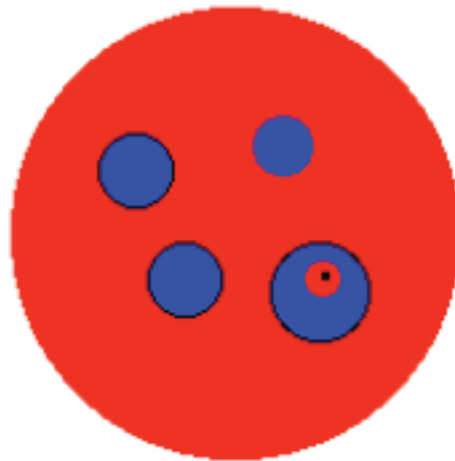
0	J1	J2	M1	G1	A1
-J1	0	J3	M2	G2	A2
-J2	-J3	0	M3	G3	A3
-M1	-M2	-M3	0	G4	A4
-G1	-G2	-G3	-G4	0	G5
-A1	-A2	-A3	-A4	-G5	0

10 generators in the 5x5 upper diagonal correspond to Dark Energy (DE) the 4 upper generators of the 6th column correspond to Dark Matter (DM) the 5th generator of the 6th column corresponds to Ordinary Matter (OM)

The basic 10 : 4 : 1 = 67 : 27 : 06 ratio of DE : DM : OM has evolved over the history of Our Universe to its present value of
DE : DM : OM = 75 : 20 : 05 (rough evolution calculation)
DE : DM : OM = 73 : 23 : 04 (measured by WMAP)
DE : DM : OM = 69 : 26 : 05 (measured by Planck)

Rabindra Mohapatra in section 14.6 of his book "Unification and Supersymmetry" said:
 "... we start with a Lagrangian invariant under full local conformal symmetry and fix its conformal and scale gauge to obtain the usual action for gravity ... the conformal d'Alembertian contains ... curvature ... R, which for constant ...

scalar field ... PHI, leads to gravity. We may call PHI the auxiliary field ...".
 I view PHI as corresponding to the Higgs 3 Special Conformal generators {G1,G2,G3} that are frozen fixed during expansion in some regions of our Universe to become Gravitationally Bound Domains (such as Galaxies) like icebergs in an ocean of water.



Since the Gravitationally Bound Domains (such as our Inner Solar System) have no Expansion Momentum we only see there the Poincare Part of Conformal Gravity plus the Higgs effects of {G4} and {G5} and the ElectroWeak Broken Symmetry caused by freezing-out fixing {G1,G2,G3}:

0	J1	J2	M1	-	A1
-J1	0	J3	M2	-	A2
-J2	-J3	0	M3	-	A3
-M1	-M2	-M3	0	G4	A4
-	-	-	-G4	0	G5
-A1	-A2	-A3	-A4	-G5	0

Irving Ezra Segal in his book "Mathematical Cosmology and Extragalactic Astronomy" said: "... Minkowski space [is] the set of all 2 x 2 Hermitian matrices ... H(2)

...

$$(t, x, y, z) \rightarrow \begin{pmatrix} t + x & y + iz \\ y - iz & t - x \end{pmatrix}$$

...

universal [Conformal] space [is] the unitary 2 x 2 group, denoted by U(2) ... [which corresponds to S1 x S3] by

...

$$(t, p) \rightarrow e^{it} u$$

where

[U(2) = U(1) x SU(2) and u is the point of SU(2) corresponding to p in S3]

...

[There is] a local causality-preserving transformation between Minkowski [R1xR3] space ... and universal [Conformal RP1 x S3] space ... [with]... two-fold covering space S1 x S3 ... oo=fold covering R1 x S3 [the coverings may be considered equivalent in cosmology discussion]

...

Any element of [the 15-dimensional Conformal Group] SU(2,2) can be represented in the form

$$\begin{pmatrix} A & B \\ C & D \end{pmatrix}$$

where A, B, C, D are ... 2x2 matrices ...[with]... the standard action

$$U \rightarrow (AU + B) (CU + D)^{-1}$$

[of Linear Fractional Mobius Transformations on unispace U(2)]...

...

Maxwell's equations and the wave equation are conformally invariant [so] the properties of solutions are basically independent of whether they are analyzed from a flat [Minkowski] or curved [Conformal] standpoint

...

the ... 15 ...[$su(2,2)$] generators of symmetries of [Conformal] unispace ... differ from the 11 generators of ... transformations in Minkowski space by terms of order $1 / R^2$, as $R \rightarrow \infty$

... R being the radius of the universe [S^3 in unispace Conformal $U(2)$]

...

the fundamental local dynamical variables of the chronometric [Conformal] theory, energy, momenta, etc., differ from those of special relativistic [Minkowski] field theory by terms of the order R^{-1} or less,

where R is the radius of the universe ... The square of the mass is ... represented by the [Conformal] D'Alembertian ...[or]...

the Casimir operator for $O(2,3)$ which differs from [the Conformal D'Alembertian] only by terms of order R^{-1} ...".

Irving Ezra Segal in his paper for "Proceedings of the Summer Research Institute on the legacy of John von Neumann" (AMS 1990) said: "... The Einstein energy H [is] the sum $H_0 + H_1$ of the conventional relativistic ... Minkowski energy H_0 and the super-relativistic [Conformal Dark] energy H_1

H_0 and H_1 are respectively scale-covariant and scale-contravariant i.e., transform like r and $1/r$ respectively.

... the decomposition $H = H_0 + H_1$ is Lorentz-covariant ..

H_0 and H_1 correspond to effective potentials of the form Lr and $-G/r$ where r is the Euclidean distance ...".

Aubert Daigneault and Atruro Sangalli in Notices of the AMS 48 (2001) 9-16 said: "...

Irving Ezra Segal ... proposed ... chronometric cosmology (CC) ...

conformal immersion of Minkowski space $M = R \times R^3$... into ... $R \times S^3$

... time coordinates x_0 [flat Minkowski] and t [curved Conformal]

are related by ... $x_0 = 2r \tan(t/2r)$

from which the relation ... redshift ... $z = \tan^2(t/2r)$ may be derived ...

the curvature of space is the reason for the ... redshift ...

x_0 tends to t as r tends to infinity. The ... differences ... can ... be

established from the series expansion of x_0 in powers of t :

$$x_0 = t + t^3 / (12r^2) + t^5 / (120r^4) + \dots$$

... a cosmological constant ... Λ ...[is]... related

to the radius r of [the unispace Conformal] S^3 by

$$r = \Lambda^{-1/2}$$

...".

Christian Beck and Michael C. Mackey in astro-ph/0703364 said: "... Electromagnetic dark energy is based on a Ginzburg-Landau ... phase transition for the gravitational activity of virtual photons ... in two different phases:

gravitationally active [GraviPhotons] ...

and gravitationally inactive [Photons] ...

Let IPI^2 be the number density of gravitationally active photons ...

start from a Ginzburg-Landau free energy density ...

$$F = a IPI^2 + (1/2) b IPI^4$$

... The equilibrium state Peq is ... a minimum of F ... for $T > Tc$...

$$Peq = 0 \text{ [and] } Feq = 0$$

... for $T < Tc$

$$|Peq|^2 = - a / b \text{ [and] } Fdeq = -(1/2) a^2 / b$$

... temperature T [of] virtual photons underlying dark energy ... is ..

$$h v = \ln 3 k T$$

... dark energy density ...[is]...

$$\rho_{\text{dark}} = (1/2) (\pi h / c^3) (v_c)^4$$

... The currently observed dark energy density in the universe of about $3.9 \text{ GeV}/m^3$ implies that the critical frequency v_c is ...

$$v_c = 2.01 \text{ THz}$$

...

BCS Theory yields ... for Fermi energy ... in copper ... 7.0 eV

and the critical temperature of ... YBCO ... around 90 K ...

$$h v_c = 8 \times 10^{-3} \text{ eV}$$

... Solar neutrino measurements provide evidence fo a neutrino mass of about $m_v c^2 = 9 \times 10^{-3} \text{ eV}$...

[E8 Physics has first-order masses for the 3 generations of neutrinos as

$$1 \times 10^{-3} \text{ and } 9 \times 10^{-3} \text{ and } 5.4 \times 10^{-2} \text{ eV }]$$

... in solid state physics the critical temperature is essentially determined by the energy gap of the superconductor ... (i.e. the energy obtained when a Cooper pair forms out of two electrons) ...

for [graviphotons] ... at low temperatures (frequencies) Cooper-pair like

states [of neutrino-antineutrino pairs] can form in the vacuum ... the ...

energy gap would be of the order of typical neutrino mass differences ...".

Clovis Jacinto de Matos and Christian Beck in arXiv 0707.1797 said: "...
 Tajmar's experiments ... at Austrian Research Centers GmbH-ARC ...
 with ... rotating superconducting rings ... demonstrated ...
 a clear azimuthal acceleration ... directly proportional to the
 superconductive ring angular acceleration, and
 an angular velocity orthogonal to the ring's equatorial plane ...
 In 1989 Cabrera and Tate, through the measurement of the London
 moment magnetic trapped flux, reported an anomalous Cooper pair mass
 excess in thin rotating Niobium superconductive rings ...
 A non-vanishing cosmological constant (Λ) can be interpreted in terms
 of a non-vanishing vacuum energy density

$$\rho_{\text{vac}} = (c^4 / 8 \pi G) \Lambda$$

which corresponds to dark energy with equation of state $w = -1$.
 The ... astronomically observed value [is]... $\Lambda = 1.29 \times 10^{(-52)} [1/m^2]$...
 Graviphotons can form weakly bounded states with Cooper pairs,
 increasing their mass slightly from m to m' .
 The binding energy is $E_c = u c^2$:

$$m' = m + m_y - u$$

... Since the graviphotons are bounded to the Cooper pairs,
 their zeropoint energies form a condensate capable of the
 gravitoelectrodynamic properties of superconductive cavities. ...
 Beck and Mackey's Ginzburg-Landau-like theory leads to a finite dark
 energy density dependent on the frequency cutoff ν_c of vacuum
 fluctuations:

$$\rho^* = (1/2) (\pi \hbar / c^3) (\nu_c)^4$$

in vacuum one may put $\rho^* = \rho_{\text{vac}}$ from which the cosmological cutoff
 frequency ν_{cc} is estimated as

$$\nu_{\text{cc}} = 2.01 \text{ THz}$$

The corresponding "cosmological" quantum of energy is:

$$E_{\text{cc}} = \hbar \nu_{\text{cc}} = 8.32 \text{ MeV}$$

... In the interior of superconductors ... the effective cutoff frequency can be
 different ... $\hbar \nu = \ln 3 k T$... we find the cosmological critical temperature T_{cc}

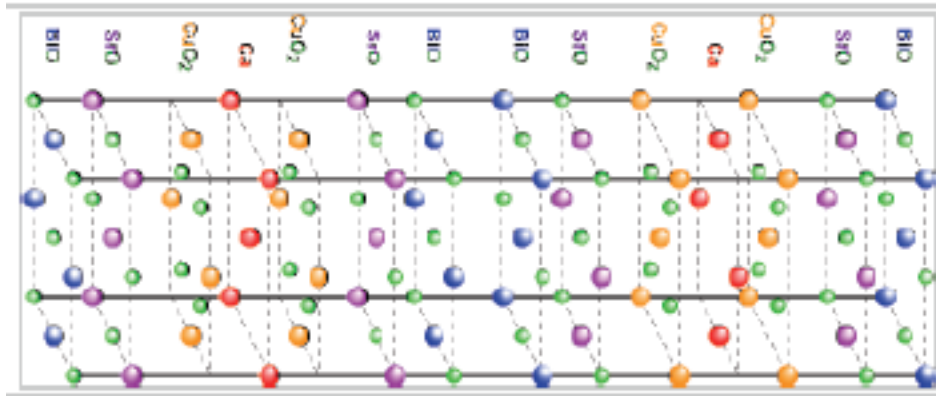
$$T_{\text{cc}} = 87.49 \text{ K}$$

This temperature is characteristic of the BSCCO High- T_c superconductor.

...".

Xiao Hu and Shi-Zeng Lin in arXiv 0911.5371 said: "... The Josephson effect is a phenomenon of current flow across two weakly linked superconductors separated by a thin barrier, i.e. Josephson junction, associated with coherent quantum tunneling of Cooper pairs. ... The Josephson effect also provides a unique way to generate high-frequency electromagnetic (EM) radiation by dc bias voltage ... The discovery of cuprate high-Tc superconductors accelerated the effort to develop novel source of EM waves based on a stack of atomically dense-packed intrinsic Josephson junctions (IJJs), since the large superconductivity gap covers the whole terahertz (THz) frequency band. Very recently, strong and coherent THz radiations have been successfully generated from a mesa structure of Bi2Sr2CaCu2O8+d single crystal ...[

BSCCO image from Wikipedia



]...

which works both as the source of energy gain and as the cavity for resonance. This experimental breakthrough posed a challenge to theoretical study on the phase dynamics of stacked IJJs, since the phenomenon cannot be explained by the known solutions of the sine-Gordon equation so far. It is then found theoretically that, due to huge inductive coupling of IJJs produced by the nanometer junction separation and the large London penetration depth ... of the material,

a novel dynamic state is stabilized in the coupled sine-Gordon system, in which +/- pi kinks in phase differences are developed responding to the standing wave of Josephson plasma and are stacked alternately in the c-axis. This novel solution of the inductively coupled sine-Gordon equations captures the important features of experimental observations.

The theory predicts an optimal radiation power larger than the one observed in recent experiments by orders of magnitude ...".