Abstract

The Overture to Beethoven’s Grosse Fugue (Opus 133) is an Outline of E8 Lie Algebra. Visualizations of Beethoven’s Grosse Fugue (Opus 133) by Stephen Malinowski show details of the correspondences between the Grosse Fugue and E8.

Since Beethoven wrote the Grosse Fugue in 1825, two years before his death in 1827, and since the E8 Lie Algebra and the Cl(16) Real Clifford Algebra in which it lives were not known to the mathematics community until Marius Sophus Lie and Wilhelm Killing invented Lie Algebras in the 1870s and 1880s and William Kingdon Clifford invented Clifford Algebras in 1878 it was not possible for Beethoven to have used the mathematics knowledge of his day in writing the Grosse Fugue but the correspondences between the Grosse Fugue Overture and the E8 Lie Algebra are far too extensive to be mere coincidence.

A possible explanation could be that (Appendix on Quantum Consciousness - page 9) our conscious brains have structure similar to the structure of E8 so that when Beethoven was composing, looking deep inside his conscious brain to “hear” music mentally that he could not hear normally because of his deafness, he was “seeing” basic structures similar to E8.

Human quantum consciousness is based on microtubules containing maximally about 65,536 Tubulin Dimers. E8 lives in the 65,536-dimensional Real Clifford Algebra Cl(16). Cl(16) is the basic structure of Our Universe (viXra 1810.0365).

so Beethoven could have been “seeing” in his mind that the E8 inside Cl(16) looks like part of the structure of microtubules of his consciousness and then writing that structure into the Grosse Fugue.

A similar line of reasoning might explain correspondences between Cl(16) Physics and the Archetype images of Jung’s Red Book (Appendix on Red Book Physics - page 23).
Visualizations of Beethoven’s Grosse Fugue (Opus 133) (about 16 minutes long) have been done by Stephen Malinowski
Its Primary Subject has 8 notes
that can be seen as basis elements of 8-dimensional Euclidean Space

According to Wikipedia, it is played in every possible variation: fortissimo and pianissimo, different rhythms, upside down and backwards.

The E8 Lie Algebra is constructed from the largest possible consistent group of reflections in 8-dim Euclidean space, analogous to the variations of the Grosse Fugue Primary Subject.

The Overture to the Grosse Fugue (24 bars, about 40 seconds)”... presents ... the material that will make up the entire piece ...” (quote from Wikipedia)

Here is how those segments of the Overture correspond to E8 Lie Algebra structures:
The initial segment introduces the instruments of the String Quartet:

first violin; second violin; viola; cello

Statement of the 8 elements of the Main Fugal Subject

corresponds to the 8 dimensions of an Octonionic Vector Space.

E8 has a D8 subalgebra that acts as rotations / reflections in a 16-dimensional Space that is an 8-complex-dimensional Complex Domain known as a Lie Ball. The Shilov Boundary of the Lie Ball is an 8-real-dimensional Lie Sphere RP1 x S7 with symmetry Spin(10) / Spin(8) x U(1) corresponding to 8-dim Octonionic Spacetime and to the 8 elements of the First Fugue.
At low energies (relative to the Planck Energy) the Octonionic Symmetry of Spacetime breaks to Quaternionic Symmetry of (4+4)-dim Kaluza-Klein $M_4 \times CP^2$

The $E_8$ Lattice 8-dim Spacetime

$E_8 \times E_8 \times E_8 = 24$-dim Leech Lattice of 26D String=World-Line Theory

The $M_4$ Physical Spacetime with Lie Sphere structure $RP^1 \times S^3$
corresponds to 1 long note (time) and 3 medium notes (space).

The $CP^2$ Internal Symmetry Space of $CP^2 = SU(3) / SU(2) \times U(1)$
corresponds to 1 medium note, 2 short notes, and one complicated medium note.

The whole thing is repeated in 3 instruments (second violin, first violin, cello) to correspond to the 24-dim Leech Lattice underlying 26D String=World-Line Theory.
Repetition of Main Fugal Subject twice, in diminution

corresponds to the two D4 subalgebras in the D8 subalgebra of E8.

The D4 for Gravity+Dark Energy is 28-dimensional with 24 Root Vectors and 4 Cartan Subalgebra elements. 12 of the Grosse Fugue notes correspond to the 12 Standard Model Ghosts. The other 12 Grosse Fugue notes correspond to the cuboctahedral Root Vectors of the SU(2,2) subalgebra of the Conformal Gravity+Dark Energy U(2,2). The 4 Cartan subalgebra elements of 16-dimensional U(2,2) are silent.

The D4 for the Standard Model is also 28-dimensional with 24 Root Vectors and 4 Cartan Subalgebra elements. 12 Grosse Fugue notes correspond to 12 of the 16 Gravity+Dark Energy Ghosts. The 4 Gravity+Dark Energy Ghost Cartan Subalgebra elements are silent. The other 8 Grosse Fugue notes correspond to the Standard Model Root Vectors of SU(3)xSU(2)xU(1). The 4 Standard Model Cartan Subalgebra elements are silent.
The Main Fugal Subject again

corresponds to 8 Fermion Particles of the First Generation.

Each of the 8 Fermion Particles has 8 Spacetime components
so they represent $8 \times 8 = 64$ elements of E8
Statement of the Other Fugal Subject with 12 + 16 elements corresponding to the 12-element Standard Model SU(3) x SU(2) x U(1) and to the 16-element Conformal Gravity+Dark Energy U(2,2) of the two 28-dimensional D4 subalgebras of the D8 subalgebra of E8.

Statement of the First Subject in the cello corresponds to 8 Fermion AntiParticles of the First Generation.

Each of the 8 Fermion AntiParticles has 8 Spacetime components so they represent 8x8 = 64 elements of E8.

The 128-dim Symmetric Space E8 / D8 is represented by Grosse Fugue notes for 8 Fermion Particles and 8 Fermion AntiParticles. The two 28-dim D4 subalgebras of 120-dim D8 are represented by Grosse Fugue notes for Standard Model and Gravity+Dark Energy. The remainder of E8 is 64-dim D8 / D4xD4 which represents A7 + R = central element of E8 Maximal Contraction Heisenberg Algebra where A7 is Symmetry of Unimodular Gravity of 8-dim Spacetime and represents Creation and Annihilation Operators for 8-dim Spacetime.

**Grosse Fugue Overture corresponds to the entire E8 Lie Algebra**

On the following page is a summary diagram of the Grosse Fugue Overture and E8:
Beethoven’s Grosse Fugue Opus 133 Overture is an Outline of E8 Lie Algebra
The Algebraic Quantum Field Theory (AQFT) structure of the Bohm Quantum Potential of 26D String Theory is given by the Cl(16) Physics Local Lagrangian

\[ \int \text{Gauge Gravity} + \text{Standard Model} + \text{Fermion Particle-AntiParticle} \]

8-dim SpaceTime

and by 8-Periodicity of Real Clifford Algebras, as the Completion of the Union of all Tensor Products of the form

\[ \text{Cl}(1,25) \times \ldots (N \text{ times tensor product}) \ldots \times \text{Cl}(1,25) \]

which is analogous to Fock Space Hyperfinite II_1 von Neumann factor algebra that is based on 2-Periodicity of Complex Clifford Algebras.

For \( N = 2^8 = 256 \) the copies of \( \text{Cl}(1,25) \) are on the 256 vertices of the 8-dim HyperCube

For \( N = 2^{16} = 65,536 = 4^8 \) the copies of \( \text{Cl}(1,25) \) fill in the 8-dim HyperCube as described by William Gilbert’s web page: “... The \( n \)-bit reflected binary Gray code will describe a path on the edges of an \( n \)-dimensional cube that can be used as the initial stage of a Hilbert curve that will fill an \( n \)-dimensional cube...”.

The vertices of the Hilbert curve are at the centers of the \( 2^8 \) sub-8-HyperCubes whose edge lengths are \( 1/2 \) of the edge lengths of the original 8-dim HyperCube.

As \( N \) grows, the copies of \( \text{Cl}(1,25) \) continue to fill the 8-dim HyperCube of E8 Space Time using higher Hilbert curve stages from the 8-bit reflected binary Gray code subdividing the initial 8-dim HyperCube into more and more sub-HyperCubes.

If edges of sub-HyperCubes, equal to the distance between adjacent copies of \( \text{Cl}(1,25) \), remain constantly at the Planck Length, then the full 8-dim HyperCube of our Universe expands as \( N \) grows to \( 2^{16} \) and beyond similarly to the way shown by this 3-HyperCube example for \( N = 2^3, 4^3, 8^3 \) from William Gilbert’s web page:
The Union of all $Cl(1,25)$ tensor products is
the Union of all subdivided 8-HyperCubes
and
their Completion is a huge superposition of 8-HyperCube Continuous Volumes
which Completion belongs to the Third Grothendieck Universe.

26D String Theory Structure is

Green, Schwartz, and Witten, in "Superstring Theory" vol. 1, describe 26D String Theory
saying ".... The first excited level ... consists of ... 
the ground state ... tachyon ...
and ... a scalar ... 'dilaton' ...
and ... $SO(24)$ ... little group of a ...[26-dim]... massless particle ... 
and ... a ... massless ... spin two state ...".
Tachyons localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions by filling their Schwinger Source regions.

Dilatons are Goldstone bosons of spontaneously broken scale invariance that (analagous to Higgs) go from mediating a long-range scalar gravity-type force to the nonlocality of the Bohm-Sarfatti Quantum Potential.

The SO(24) little group is related to the Monster automorphism group that is the symmetry of each cell of Planck-scale local lattice structure.

**The massless spin 2 state = Bohmion = Carrier of the Bohm Force of the Bohm Quantum Potential.**

**Similarity of the spin 2 Bohmion to the spin 2 Graviton accounts for the Bohmion’s ability to support Penrose Consciousness with Superposition Separation Energy Difference G m^2 / a**

where, for a Human Brain, m = mass of electron and a = 1 nanometer in Tubulin Dimer

“... Bohm’s Quantum Potential can be viewed as an internal energy of a quantum system ...

according to Dennis, de Gosson, and Hiley (arXiv 1412.5133 ) and

**Bohm Quantum Potential inherits Sarfatti Back-Reaction from its spin-2 structure similar to General Relativity**

Peter R. Holland says in "The Quantum Theory of Motion" (Cambridge 1993): "... the total force ... from the quantum potential ... does not ... fall off with distance ... because ... the quantum potential ... depends on the form of ...[the quantum state]... rather than ... its ... magnitude ...".

**Penrose-Hameroff-type Quantum Consciousness is due to Resonant Quantum Potential Connections among Quantum State Forms.**

The Quantum State Form of a Conscious Brain is determined by the configuration of a subset of its 10^18 to 10^19 Tubulin Dimers described by a large Real Clifford Algebra.

Paola Zizzi in gr-qc/0007006 describes the Octonionic Inflation Era of Our Universe as a Quantum Consciousness Superpositon of States ending with Self-Decoherence after 64 doublings of Octonionic Inflation, at which time Our Universe is "... a superposed state of quantum ... [ qubits ].

the self-reduction of the superposed quantum state is ... reached at the end of inflation ...[at]... the decoherence time ... [ Tdecoh = 10^9 Tplanck = 10^(^-34) sec ] ...

and corresponds to a superposed state of ... [ 10^19 = 2^64 qubits ]. ...".

64 doublings to 2^64 qubits corresponds to the Clifford algebra

\[ Cl(64) = Cl(8x8) = Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \times Cl(8) \]

By the periodicity-8 theorem of Real Clifford algebras, Cl(64) is the smallest Real Clifford algebra for which we can reflexively identify each component Cl(8) with a basis vector in the Cl(8) vector space.

This reflexive identification causes our universe to decohere at \( N = 2^{64} = 10^{19}. \)
Octonionic Quantum Processes are Not Unitary and so can produce Fermions.  
(see Stephen Adler's book "Quaternionic Quantum Mechanics ..." at pages 50-52 and 561).  
At the end of 64 Unfoldings, Non-Unitary Octonionic Inflation ended having produced about \((1/2) \times 16^{64} = (1/2) \times (2^4)^{64} = 2^{255} = 6 \times 10^{76}\) Fermions.  
At the End of Inflation Our Universe had Temperature / Energy \(10^{27} \text{ K} = 10^{14} \text{ GeV}\)  
so each of the \(10^{77}\) Fermions had energy of \(10^{14} \text{ GeV}\) and collisions among them would for each of the \(10^{77}\) Fermions produce jets containing about \(10^{12}\) particles of energy 100 GeV or so that the total number created by Inflation was about \(10^{89}\).  
The End of Inflation time was at about \(10^{(-34)} \text{ sec} = 2^{64} \text{Tplanck}\)  
and  
the size of our Universe was then about \(10^{(-24)} \text{ cm}\) which is about the size of a Fermion Schwinger Source Kerr-Newman Cloud.  
The \(2^{64}\) qubits created by Inflation is roughly \(10^{19}\) which is roughly the number of Quantum Consciousness Tubulins in the Human Brain.  
Therefore  

**the Human Brain Quantum Consciousness has evolved in Our Universe to be roughly equivalent to the Maximum Consciousness of Our Inflationary Era Universe.**  

Further, each cell of E8 Lagrangian Spacetime corresponds to 65,536-dim Cl(16) which contains 248-dim E8 = 120-dim D8 bivectors +128-dim D8 half-spinors  
Human Brain Microtubules 40 microns long have 65,536 Tubulin Dimers  
and so can have Bohm Quantum Resonance with Cl(16) Spacetime cells so that at any and all Times the State of Consciousness of a Human is in exact resonant correspondence with a subset of the cells of E8 Classical Lagrangian Spacetime  
Therefore  

**E8 Lagrangian Spacetime (as a Nambu-Jona-Lasinio Condensate) is effectively the Spirit World in which the Human States of Consciousness = Souls exist.**  
After the death of the Human Physical Body the Spirit World interactions with its Soul are no longer constrained by Physical World interactions with its Body so that the Spirit World can harmonize the individual Soul with the collective Universal Soul.
A Single Cell of E8 26-dimensional Bosonic String Theory, in which Strings are physically interpreted as World-Lines, can be described by taking the quotient of its 24-dimensional O+, O-, Ov subspace modulo the 24-dimensional Leech lattice. Its automorphism group is the largest finite sporadic group, the Monster Group, whose order is

\[ 8080, 17424, 79451, 28758, 86459, 90496, 17107, 57005, 75436, 80000, 00000 = 2^{46} \cdot 3^{20} \cdot 5^9 \cdot 7^6 \cdot 11^2 \cdot 13^3 \cdot 17 \cdot 19 \cdot 23 \cdot 29 \cdot 31 \cdot 41 \cdot 47 \cdot 59 \cdot 71 \]
or about \(8 \times 10^{53}\).

“... Bohm’s Quantum Potential can be viewed as an internal energy of a quantum system ...” according to Dennis, de Gosson, and Hiley (arXiv 1412.5133) and Peter R. Holland says in "The Quantum Theory of Motion" (Cambridge 1993): "... the total force ... from the quantum potential ... does not ... fall off with distance ... because ... the quantum potential ... depends on the form of ...[the quantum state]... rather than ... its ... magnitude ...".

Penrose-Hameroff-type Quantum Consciousness is due to Resonant Quantum Potential Connections among Quantum State Forms. The Quantum State Form of a Conscious Brain is determined by the configuration of a subset of its \(10^{18}\) to \(10^{19}\) Tubulin Dimers with math description in terms of a large Real Clifford Algebra:

Resonance is discussed by Carver Mead in “Collective Electrodynamics" (MIT 2000):

"... we can build ... a resonator from ... electric dipole ... configuration[s] ... [such as Tubulin Dimers ]

Because there are charges at the two ends of the dipole, we can have a contribution to the electric coupling from the scalar potential ... as well [as] from the magnetic coupling ... from the vector potential ... electric dipole coupling is stronger than magnetic dipole coupling ... the coupling of ... two ... configurations ... is the same, whether retarded or advanced potentials are used. Any ... configuration ... couples to any other on its light cone, whether past or future. ... The total phase accumulation in a ... configuration ... is the sum of that due to its own current, and that due to currents in other ... configurations ... far away ...

The energy in a single resonator alternates between the kinetic energy of the electrons (inductance), and the potential energy of the electrons (capacitance). With the two resonators coupled, the energy shifts back and forth between the two resonators in such a way that the total energy is constant ... The conservation of energy holds despite an arbitrary separation between the resonators ... Instead of scaling linearly with the number of charges that take part in the motion, the momentum of a collective system scales as the square of the number of charges! ... The inertia of a collective system, however, is a manifestation of the interaction, and cannot be assigned to the elements separately. ... Thus, it is clear that collective quantum systems do not have a classical correspondence limit. ..."
For the $10^{18}$ Tubulin Dimers of the human brain, the resonant frequencies are the same and exchanges of energy among them act to keep them locked in a Quantum Protectorate collective coherent state.

Philip W. Anderson in cond-mat/0007287 and cond-mat/007185 said: "... Laughlin and Pines have introduced the term "Quantum protectorate" as a general descriptor of the fact that certain states of quantum many-body systems exhibit properties which are unaffected by imperfections, impurities and thermal fluctuations. They instance ... flux quantization in superconductors, equivalent to the Josephson frequency relation which again has mensuration accuracy and is independent of imperfections and scattering. ...

... the source of quantum protection is a collective state of the quantum field involved such that the individual particles are sufficiently tightly coupled that elementary excitations no longer involve a few particles but are collective excitations of the whole system, and therefore, macroscopic behavior is mostly determined by overall conservation laws ... a "quantum protectorate" ...[ is ]... a state in which the manybody correlations are so strong that the dynamics can no longer be described in terms of individual particles, and therefore perturbations which scatter individual particles are not effective ...".

Mershin, Sanabria, Miller, Nawarathna, Skoulakis, Mavromatos, Kolomenskii, Scheussler, Ludena, and Nanopoulos in physics/0505080 “Towards Experimental Tests of Quantum Effects in Cytoskeletal Proteins” said:

Classically, the various dimers can only be in the ... conformation. Each dimer is influenced by the neighboring dimers resulting in the possibility of a transition. This is the basis for classical information processing, which constitutes the picture of a (classical) cellular automaton.

If we assume ... that each dimer can find itself in a QM superposition of ...[ those ]... states, a quantum nature results. Tubulin can then be viewed as a typical two-state quantum mechanical system, where the dimers couple to conformational changes with $10^{-9}$ - $10^{-11}$ sec transitions, corresponding to an angular frequency $\sim 10^{10}$ - $10^{12}$ Hz. In this approximation, the upper bound of this frequency range is assumed to represent (in order of magnitude) the characteristic frequency of the dimers, viewed as a two-state quantum-mechanical system ...

The Energy Gap of our Universe as superconductor condensate spacetime is from $3 \times 10^{(-18)}$ Hz (radius of universe) to $3 \times 10^{43}$ Hz (Planck length). Its RMS amplitude is $10^{13}$ Hz = 10 THz = energy of neutrino masses = critical temperature $T_c$ of BSCCO superconducting crystal Josephson Junctions ...

large-scale quantum coherence ...[ has been observed ]... at temperatures within a factor of three of biological temperatures. MRI magnets contain hundreds of miles of superconducting wire and routinely carry a persistent current. There is no distance limit - the macroscopic wave function of the superfluid condensate of electron pairs, or Cooper pairs, in a sufficiently long cable could maintain its quantum phase coherence for many thousands of miles ... there is no limit to the total mass of the electrons participating in the superfluid state. The condensate is “protected” from thermal fluctuations by the BCS energy gap at the Fermi surface ... The term “quantum protectorate” ... describe[s] this and related many-body systems ...".
The Human Brain has about $10^{11}$ Neuron cells, each about 1,000 nm in size. The cytoskeleton of cells, including neurons of the brain, is made up of Microtubules.

Each Neuron contains about $10^9$ Tubulin Dimers, organized into Microtubules some of which are organized by a Centrosome. Centrosomes contain a pair of Centrioles.

A Centriole is about 200 nm wide and 400 nm long. Its wall is made up of 9 groups of 3 Microtubules, reflecting the symmetry of 27-dim $J(3,0)$. 
Each Microtubule is a hollow cylindrical tube with about 25 nm outside diameter and 14 nm inside diameter, made up of 13 columns of Tubulin Dimers.

Each Tubulin Dimer is about 8 nm x 4 nm x 4 nm, consists of two parts, alpha-tubulin and beta-tubulin (each made up of about 450 Amino Acids, each containing roughly 20 Atoms).

A Microtubule 40 microns = 40,000 nm long contains $13 \times \frac{40,000}{8} = 65,000$ Dimers.

The black dots indicate the position of the Conformation Electrons. There are two energetically distinct configurations for the Tubulin Dimers:

- Conformation Electrons Similarly Aligned (left image) - State 0
- Conformation Electrons Maximally Separated (right image) - State 1

The two structures - State 0 ground state and State 1 higher energy state - make Tubulin Dimers the basis for a Microtubule binary math / code system.
Microtubule binary math / code system corresponds to Clifford Algebras Cl(8) and Cl(8)xCl(8) = Cl(16) containing 16-dim V16 (magenta) and 120 (inside purple outline) + 128-dim (yellow green red) = 248-dim E8 and 560 (inside black outline) 10 copies of 56-dim Fr3(O):

That leaves 1 (orange) + and 127 (blue) = 128-dim Mirror Fermion half-spinors and 65,536 - 256 - 560 - 120 - 16 = 64,584 elements of Cl(16) available to carry information in the processes of Quantum Consciousness.

According to 12biophys.blogspot.com Lecture 11 Microtubule structure is dynamic: “... One end of the microtubule is composed of stable (GTP) monomers while the rest of the tubule is made up of unstable (GDP) monomers. The GTP end comprises a cap of stable monomers. Random fluctuations either increase or decrease the size of the cap."
This results in 2 different dynamic states for the microtubule. 
Growing: cap is present 
Shrinking: cap is gone ...

Microtubules spend most of their lives between 10 microns and 40 microns, sizes that can represent E8 as half of the Even Part (half) of Cl(16) ( 10 microns ) or as the Even Part (half) of Cl(16) ( 20 microns ) or as full Cl(16) ( 40 microns ).

In a given Microtubule
the 128 Cl(8) Half-Spinor part is represented by a line of 128 Dimers in its stable GTP region and

the 120 Cl(16) BiVector part by a 12 x 10 block of Dimers in its stable GTP region
The 560 Cl(16) TriVector part is represented similarly.

( image adapted from 12biophys.blogspot.com Lecture 11 )
How do the Microtubules communicate with each other?

Consider the Superposition of States State 0 and State 1 involving one Tubulin Dimer with Conformation Electron mass m and State1 / State 0 position separation a.

The Superposition Separation Energy Difference is the internal energy

\[ E_{ssediff} = G \frac{m^2}{a} \]

that can be seen as either the energy of 26D String Theory spin two gravitons or the Bohm Quantum Potential internal energy, equivalently.

Communication between two Microtubules is by the Bohm Quantum Potential between their respective corresponding Dimers with the correspondence being based on connection between respective E8 and Fr3(O) subsets

How is information encoded in the Microtubules?

Each Microtubule contains E8 and Fr3(O), allowing Microtubules to be correlated with each other. The parts of the Microtubule beyond E8 and Fr3(O) are in Cl(16) for 40 micron Microtubules, or the Even Subalgebra of Cl(16) for 20 micron Microtubules, or half of the Even Subalgebra of Cl(16) for 10 micron Microtubules so since by 8-Periodicity of Real Clifford Algebras Cl(16) = Cl(8) x Cl(8) and since Cl(8) information is described by the Quantum Reed-Muller code [[256, 0, 24]] the information content of Cl(16) and its Subalgebras is described by the Tensor Product Quantum Reed-Muller code [[256, 0, 24]] x [[256, 0, 24]]

What about information in the Many Microtubules of Human Consciousness?

The information in one Microtubule is based on Cl(16) which is contained in the Cl(1,25) of 26D String Theory E8 Physics

How does this give rise to Penrose-Hameroff Quantum Consciousness?

Consider the Superposition of States State 0 and State 1 involving one Tubulin Dimer with Conformation Electron mass m and State1 / State 0 position separation a. The Superposition Separation Energy Difference is the internal energy

\[ E_{ssediff} = G \frac{m^2}{a} \]

that can be seen as the energy of 26D String Theory spin two gravitons which physically represent the Bohm Quantum Potential internal energy. For a given Tubulin Dimer a = 1 nanometer = 10^-7 cm so that

\[ T = \frac{h}{E_{electron}} = \left( \frac{\text{Compton}}{\text{Schwarzschild}} \right) \left( \frac{a}{c} \right) = 10^{26} \text{ sec} = 10^{19} \text{ years} \]
Now consider the case of N Tubulin Dimers in Coherent Superposition connected by the Bohm Quantum Potential Force that does not fall off with distance. Jack Sarfatti defines coherence length \( L \) by \( L^3 = N a^3 \) so that the Superposition Energy \( E_N \) of \( N \) superposed Conformation Electrons is

\[
E_N = G M^2 / L = N^{(5/3)} E_{\text{ssediff}}
\]

The decoherence time for the system of \( N \) Tubulin Electrons is

\[
T_N = h / E_N = h / N^{(5/3)} E_{\text{ssediff}} = N^{(-5/3)} 10^{26} \text{ sec}
\]

so we have the following rough approximate Decoherence Times \( T_N \)

<table>
<thead>
<tr>
<th>Number of Involved Tubulin Dimers</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 10^{(11+9)} = 10^{20} )</td>
<td>( 10^{(-33 + 26)} = 10^{(-7)} \text{ sec} )</td>
</tr>
<tr>
<td>( 10^{16} )</td>
<td>( 10^{(-27 + 26)} = 10^{(-1)} \text{ sec} - 10 \text{ Hz} )</td>
</tr>
</tbody>
</table>

Human Alpha EEG is 8 to 13 Hz

Fundamental Schumann Resonance is 7.8 Hz

Time of Traverse by a String World-Line Quantum Bohmion of a Quantum Consciousness Hamiltonian Circuit of \( 10^{16} \text{ TD} \) separated from nearest neighbors by 10 nm is \( 10^{16} \times 10 \text{ nm} / c = (10^{16} \times 10^{(-6)}) \text{ cm} / c = 10^{10} \text{ cm} / c = 0.3 \text{ sec} \)
Each cell of E8 Classical Lagrangian Spacetime corresponds to 65,536-dim \( \text{Cl}(16) \) which contains 248-dim \( \text{E8} = 120 \)-dim \( \text{D8} \) bivectors + 128-dim \( \text{D8} \) half-spinors.

In E8 Physics (viXra 1602.0319)

**Spacetime is the 8-dimensional Shilov Boundary \( \mathbb{RP}^1 \times S^7 \)**

of the **Type IV8 Bounded Complex Domain Bulk Space**

of the Symmetric Space \( \text{Spin}(10) / \text{Spin}(8) \times \text{U}(1) \)

which **Bulk Space** has 16 Real dimensions

and is the Vector Space of the Real Clifford Algebra \( \text{Cl}(16) \).

By 8-Periodicity,

\( \text{Cl}(16) = \text{tensor product} \ \text{Cl}(8) \times \text{Cl}(8) = \text{Real 256x256 Matrix Algebra} \ \text{M}(\mathbb{R},256) \)

and so has 256x256 = 65,536 elements.

\( \text{Cl}(8) \) has 8 Vectors, 28 BiVectors, and 16 Spinors with 8+28+16 = 52 = F4 Lie Algebra.

\( \text{Cl}(16) \) has 120 BiVectors and 128 Half-Spinors for 120+128 = 248 = E8 Lie Algebra

giving a Lagrangian for the Standard Model and for Gravity - Dark Energy.

\( \text{Cl}(16) \) has 560 TriVectors for 10 copies of \( \text{Fr3(O)} \) and \( \text{Cl}(1,25) \) AQFT

so 65,536 - 248 - 560 = 64,728 elements of \( \text{Cl}(16) \) are for Consciousness Information.

The Complex Bulk Space \( \text{Cl}(16) \)

contains the Maximal Contraction of E8 which is \( \text{H92} + \text{A7} \)
a generalized Heisenberg Algebra of Quantum Creation-Annihilation Operators with graded structure

\[ 28 + 64 + ((\text{SL}(8,\mathbb{R})+1)) + 64 + 28 \]
Human Brain Microtubules 40 microns long have 65,536 Tubulin Dimers

and so can have Bohm Quantum Resonance with Cl(16) Spacetime cells

so that at any and all Times

the State of Consciousness of a Human

is in exact resonant correspondence with

a subset of the cells of E8 Classical Lagrangian Spacetime

Therefore

E8 Classical Lagrangian Spacetime NJL Condensate is effectively the Spirit World

in which the Human States of Consciousness = Souls exist. After the death of the

Human Physical Body the Spirit World interactions with its Soul are no longer

constrained by Physical World interactions with its Body so that the Spirit World can

harmonize the individual Soul with the collective Universal Soul. William Kingdon

Clifford, who invented Real Clifford Algebras, called them “mind-stuff”, saying: “…

When matter takes the complex form of a living human brain,

the corresponding mind-stuff takes the form of a human consciousness …”.

RED BOOK PHYSICS

How Jung’s Red Book Archetypes connect with E8 - Cl(16) Physics

Frank Dodd (Tony) Smith, Jr. - 2018

The first five pages after the cover summarize the rest of this paper.
CLIFFORD ALGEBRAS to E8

CLIFFORD EVOLUTION of OUR UNIVERSE

CREATION - OCTONIONIC NON-UNITARY INFLATION

28+64+28 = 120 D8 = 4X32 = 128 D8 HALF-SPINOR

E8 - PARTICLES and FORCES - 8D LAGRANGIAN - TRIALITY
E8 HEISENBERG CREATION-ANNIHILATION - \(28+64+(63+1)+64=28\)

AFTER INFLATION - QUATERNIONIC UNITARY EXPANSION

now - DE : DM : OM = 0.75 : 0.21 : 0.04

E8 = H4 STANDARD MODEL  \(\text{CP2} + \text{H4 GRAVITY} + \text{DARK ENERGY M4}\)

STRINGS = WORLD LINES 26D STRING THEORY - SPIN-2 BOHMIONS

QUANTUM BLOCKCHAINS OF SCHWINGER SOURCES
HIGGS = NAMBU-JONA-LASINIO TRUTH QUARK COMPOSITE
FERMILAB TRUTH QUARK MASSES 130 GeV - 174 GeV - 220 GeV
CMS HIGGS MASSES 125 GeV - 195 GeV - 260 GeV

M4xCP2 KALUZA-KLEIN - MAYER HIGGS - 3 FERMION GENERATIONS

FERMION OCTONIONIC BRAIDS - FERMION MASSES
D4 STANDARD MODEL and GRAVITY+DE GHOSTS
D4 GRAVITY+DE and STANDARD MODEL GHOSTS

FORCE STRENGTHS - 4D LAGRANGIAN - CALCULATION RESULTS

E8 - H4 - F4 - D4 - D3=A3 - H3 - H2=PENROSE STAR
William Kingdon Clifford (1845 - 1879) described Geometry in terms of his invention: Real Clifford Algebras, which he called “mind-stuff”, saying:

“... That element of which ... even the simplest feeling is a complex, I shall call Mind-stuff. A moving molecule of inorganic matter does not possess mind or consciousness; but it possesses a small piece of mind-stuff. ... When molecules are ... combined together ... the elements of mind-stuff which go along with them ... combine ... to form the ... beginnings of Sentience. When the molecules are so combined as to form the brain and nervous system ... the corresponding elements of mind-stuff are so combined as to form some kind of consciousness ... changes in the complex which take place at the same time get so linked together that the repetition of one implies the repetition of the other. When matter takes the complex form of a living human brain, the corresponding mind-stuff takes the form of a human consciousness ...”.

Clifford Algebra = Algebra of Spaces =
= Fundamental Human Understanding

For our 3-dim Space with coordinates x y z
Cl(3) describes
1 - all of 3-space itself

3 - three types of planes in space:
xy yz zx

3 - three types of lines / directions in space:
x y z

1 - one type of 0-dim point

so
Cl(3) of 3-dim space has total dimension
1+3+3+1 = 2^3 = 8
Generally, $\text{Cl}(N)$ of N-dim space has dimension $2^N$, so the process of forming Clifford Algebra creates $2^N$-dim spaces from N-dim spaces.

THIS IS HOW OUR UNIVERSE GREW FROM NOTHING:
Cl(16) = $2^{16}$ = 65,536 dimensions with graded structure
1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1

The 120 grade-2 BiVectors form the D8 Lie Algebra
that is related to rotations in 16-dim space

The Real Clifford Algebra Cl(16) = 256 x 256 Real Matrix Algebra

The 256 first-column-vectors are the Spinors of D8
that are related to entanglement of connections to 16-dim space
The 256 D8 Spinors break down into two half-Spinors
256 = 128 + 128

The 128 and 128 half-spinors are mirror images of each other
so 128 can describe all useful physics by itself.

120 D8 BiVectors + 128 D8 half-Spinors = 248-dim E8
248-dim E8 lives in Cl(16) containing 120-dim D8 biVectors of Cl(16)

E8 / D8 = 64 + 64 Fermions = 128-dim D8 half-Spinors of Cl(16)

D8 / D4 x D4 = 64 Spacetime

D4 = 28 Standard Model (12) with 16 Gravity + Dark Energy Ghosts

D4 = 28 Gravity + Dark Energy (16) with 12 Standard Model Ghosts
Dimension of Clifford Algebra

\[
\begin{array}{cccccc}
0 & 2^0=1 & 2^1=2 & 2^2=4 & 2^4=16 & 2^8=65536 & 256x256 \\
VOID \to Cl(VOID) \to Cl(0,0) \to Cl(0,1) \to Cl(0,2) \to Cl(0,3) \to Cl(0,4) \to Cl(0,8) \to Cl(0,16) \to Cl(0,24) \to M(2,Cl(0,24)) \to Cl(1,25) \to
\end{array}
\]

\[
\rightarrow \text{Completion of Union of All Tensor Products of } Cl(1,25) = \text{hyperfine AQFT}
\]

\[
Cl(1,25) = Cl(1,9) \times Cl(0,8) \times Cl(0,8) \text{ and } Cl(1,9) = Cl(1,5) \times Cl(0,4) = Cl(2,4) \times Cl(0,4)
\]

The completion of the union of all tensor products of \( Cl(16) = Cl(8) \times Cl(8) \) produces a generalized hyperfinite III \(_1\) von Neumann factor that gives the \( Cl(16)\)-E8 model a natural Algebraic Quantum Field Theory.

The \( Cl(16)\)-E8 AQFT inherits structure from the \( Cl(16)\)-E8 Local Lagrangian.

The Creation-Annihilation Operator structure of \( Cl(16)\)-E8 AQFT is given by the Maximal Contraction of \( E8 = \text{semidirect product } A7 \times H2 \)

where \( H2 = (22+1) \oplus 1 = 108\)-dim Heisenberg algebra and \( A7 = 63\)-dim \( SU(8) \)

\[
\begin{align*}
240 E8 \text{ Root Vectors} \\
1/2 &= 56 + \bar{56} = (24+32) + (24-32) \\
1/28 &= 1 + 26 + 1
\end{align*}
\]

**Timelike AntiNeutrino**

\[
\begin{align*}
&1 &+ &+ &+ &+ &1 \\
&56 &+ &+ &+ &+ &56 \\
&126 &+ &+ &+ &1 &\text{SU(2)}
\end{align*}
\]
When Our Planck Scale Universe emerged from its Parent Universe by Quantum Fluctuation it was described by SO(16) symmetry of Compact E8(-248).

E8 Compact Form E8(-248) with Symmetric Space E8 / Spin(16) represents Our Planck Scale Universe when it emerged from its Parent Universe by Quantum Fluctuation.
E8 Split Form EVIII E8(8) with Symmetric Space E8 / SO(8,8) represents Our Universe during Octonionic Inflation with Non-Unitary Quantum Processes.
Lagrangian

D8 / D4xD4

D4_{sm}

D4_{gde}

E8 / D8

CP2

8 x 8 position x momentum

A7+1

M4

the Octonionic Inflation Unfolding Process creates Fermion Particles with no Antiparticles
Creation-Annihilation Operators for 8 components of 8+8 Fermions are odd-grade-+/-1 part of E8 Maximal Contraction generalized Heisenberg Algebra

\[ h^{92} \times A7 = 28 + 64 + ((SL(8,\mathbb{R})+1) + 64 + 28 \]

Big Bang E8(-248) : Spin(16) I Octonion Inflation E8(8) : SO(8,8) I Quaternion Conformal Evolution E8(-24) : SO^*(16)

At the end of Non-Unitary Octonionic Inflation our Universe had about (1/2) 16^64 = (1/2) (2^4)^64 = 2^255 = 6 x 10^76 Fermion Particles
the size of our Universe was then about 10^(-24) cm
which is about the size of a Fermion Schwinger Source Kerr-Newman Cloud
The End of Inflation time was at about 10^(-34) sec = 2^64 TPlanck
The Zizzi Inflation phase of our universe ends with decoherence "collapse" of the 2^64 Superposition Inflated Universe into Many Worlds of Quantum Theory,

Paola Zizzi in gr-qc/0007006:
"... The self-reduction of the superposed quantum state ... corresponds to a superposed state of ... [ 10^19 = 2^64 qubits ] ... also the number of superposed tubulins-qubits in our brain ... leading to a conscious event. ..."
Inflation ends when a preferred Quaternionic Subspacetime freezes out, converting 8 dim Spacetime into 4+4 dim M4 x CP2 Spacetime where
M4 = Physical Minkowski Spacetime and
CP2 = SU(3) / U(2) Internal Symmetry Space
Octonionic Integral becomes two Quaternionic Integrals

8-dim Octonionic Spacetime was broken into
(4+4)-dim Unitary Quaternionic M4 x CP2 Kaluza-Klein Spacetime
with SO*(16) symmetry of EIX E8(-24).
That transition was
a Weyl Unitary Trick within E8(8) from SO(8,8) to SO*(16)
followed by
a shifting of SO*(16) symmetry from E8(8) to E8(-24)
E8 form EIX E8(-24) with Symmetric Space E8 / SO*(16)
represents Our Universe after End of Inflation
The Cl(16)-E8 AQFT inherits structure from the C(16)-E8 Local Lagrangian

\[ \int \text{Standard Model Gauge Gravity} + \text{Fermion Particle-AntiParticle} \]

8-dim SpaceTime

The Cl(16)-E8 model at the Planck Scale has spacetime condensing out of Clifford structures forming a Leech lattice underlying 24-dim String Theory of World-Lines with \(8 + 8 + 8 = 24\) of fermion particles and antiparticles and of spacetime.

Slices of 8v SpaceTime are represented as D8 branes. Each D8 brane has Planck-Scale Lattice Structure superpositions of 8 types of E8 Lattice denoted by 1E8, 1E8, 1E8, 1E8, 1E8, 1E8, 1E8, 1E8

Stack D8 branes to get SpaceTime with Strings = World-Lines

Let Oct16 = discrete multiplicative group \(\{\pm 1, \pm i, \pm j, \pm k, \pm i, \pm j, \pm k, \pm i, \pm j, \pm k\}\).

Orifold by Oct16 the 8s+ to get 8 Fermion Particle Types

Orifold by Oct16 the 8s- to get 8 Fermion AntiParticle Types

Gauge Bosons from 1E8 and EE8 parts of a D8 give U(2) Electroweak Force

Gauge Bosons from 1E8, 1E8, and KE8 parts of a D8 give SU(3) Color Force

Gauge Bosons from 1E8, 1E8, 1E8, and KE8 parts of a D8 give U(2,2) Conformal Gravity

The 8x8 matrices for collective coordinates linking one D8 to the next D8 give Position x Momentum

The automorphism group of a single 24-dim String Theory cell modulo the Leech lattice is the Monster Group of order about \(8 \times 10^{43}\).

When a fermion particle/antiparticle appears Tachyons create a cloud of particles/antiparticles. The cloud is one Planck-scale Fundamental Fermion Valence Particle plus an effectively neutral cloud of particle/antiparticle pairs forming a Kerr-Newman black hole.

That cloud constitutes the Schwinger Sources.

The Schwinger Sources are finite regions in a Complex Domain spacetime corresponding to Green's functions of particle creation/annihilation.

Its structure comes from the 24-dim Leech lattice part of the Monster Group which is \(2^{4}(1+24)\) times the double cover of Co1, for a total order of about \(10^{26}\).

(Since a Leech lattice is based on copies of an E8 lattice and since there are 7 distinct E8 integral domain lattices there are 7 (or 8 if you include a non-integral domain E8 lattice) distinct Leech lattices.

The physical Leech lattice is a superposition of them, effectively adding a factor of 8 to the order.)

The volume of the Kerr-Newman Cloud is on the order of \(10^{27} \times\) Planck scale, = roughly \(10^{-24}\) cm.
Julian Schwinger describes Elementary Particles as volumes of space - Sources - whose properties are determined by Green's Functions characteristic of the volumes.

In E8 Physics any Elementary Particle is immediately surrounded by a cloud of virtual particle-antiparticle pairs similar to a Kerr-Newman Black Hole with Symmetric Space - Bounded Complex Domain - Shilov Boundary structure corresponding to its Gauge Group properties. The Poisson Kernel - Bergman Kernel defines the Green's Function.

The initial Valence Particle is Planck scale. The number of Virtual Particles is determined by the Planck scale geometry of spacetime. The E8 model at the Planck Scale has spacetime condensing out of Clifford structures forming a Lorentz Leech lattice underlying 26-dim String Theory of World-Lines with $8 + 8 + 8 = 24$-dim of fermion particles and antiparticles and of spacetime. The automorphism group of one 26-dim String Theory cell modulo the Leech lattice is the Monster Group of order about $8 \times 10^{45}$. The Cloud structure comes from the 24-dim Leech lattice part of the Monster Group which is $2^{4}(1+24)$ times the double cover of $Co1$, for an order of about $10^{26}$. Due to superpositions of algebraically independent E8 Lattices the total number of Virtual particle/antiparticle pairs is about $10^{27}$ so the volume of the Kerr-Newman Cloud is on the order of $10^{27} \times$ Planck scale, and its size should be about $10^{24}(27/3) \times 1.6 \times 10^{-33} \text{ cm} = \text{ roughly } 10^{24}(24) \text{ cm}.$

Each Schwinger Source particle-antiparticle pair should see (with Bohm Quantum Potential and Scaffari Back-Reflection) the rest of our Universe in the perspective of $8 \times 10^{45}$ Monster Symmetry so a Schwinger Source acting as a Jewel of Indra's Net of Schwinger Source Bohm Quantum Blockchain Physics can see $10^{27} \times 8 \times 10^{45} = 8 \times 10^{60}$ Other Sources of an Indra's Net.

To fit inside the initial Schwinger Source the Information Elements of all the Other Schwinger Sources of Our Universe ($10^{27} \text{ or so}$) should be distributed as a Fractal Julia Set. There are $2^{n}$ stage-n cells in a Binary Decomposition of Julia Sets, so a stage-256 Julia level set based on Binary Decomposition has $2^{256} = \text{ about } 10^{77}$ cells so Full Indra Net information can be seen/ reflected by each Schwinger Source Indra Jewel.

Each Schwinger Source contains $10^{27}$ Virtual pairs of particles each of which can see along a connecting Line an Other Indra's Net Source which Line sees Other Sources through Monster Group Lens elements so that the Other Source appears to be a Julia Set.

Each Schwinger Source has a Mandelbrot Set that tells its Source what each of the many Indra's Net Sources Julia set looks like by correlating Monster Group Lens Elements with Types of Julia Set. Self-Perception is always the $c = 0$ Circle Julia Set.
Critical Point
250 H, 220 Tq

Non-Perturbativity

Composite H as Tq-Tantiq Condensate
195 H, 174 Tq

Normal Stable Ground State
125 H, 130 Tq

Instability
Splitting Octonionic Spacetime into Quaternionic M4 x CP2 Kaluza-Klein over CP2 produces Higgs by the Mayer Mechanism and Second and Third Generation Fermions.

First Generation Fermions are represented by Octonions O.

Second Generation Fermions are represented by Octonion Pairs O x O.

Third Generation Fermions are represented by Octonion Triples O x O x O.
Quaternionic E7xSU(2) structure breaks 8-dim Spacetime Octonionic Symmetry to Quaternionic (4+4)-dim Associative x CoAssociative Kaluza-Klein Spacetime
(see Reese Harvey “Spinors and Calibrations” (Academic 1990))
where M4 = 4-dim Minkowski Physical Spacetime is Associative
and CP2 = SU(3) / SU(2) x U(1) Internal Symmetry Space is CoAssociative

Meinhard Mayer said (Hadronic Journal 4 (1981) 108-152): “... each point of ...
the ... fibre bundle ... E ...

... consists of
a four- dimensional spacetime point x [ in M4 ]
to which is attached the homogeneous space G / H [ SU(3) / U(2) = CP2 ]

... the components of the curvature lying in the homogeneous space G / H could be reinterpreted as Higgs scalars (with respect to spacetime [ M4 ])

... the Yang-Mills action reduces to a Yang-Mills action for the h-components [ U(2) components ] of the curvature over M [ M4 ] and a quartic functional for the “Higgs scalars”, which not only reproduces the Ginzburg-Landau potential, but also gives the correct relative sign of the constants, required for the BEHK ... Brout-Englert-Higgs-Kibble ... mechanism to work. ...”.

(see Appendix - Details of Mayer - Higgs)
3 Generations of Fermions

In Kaluza-Klein M4 x CP2 there are 3 possibilities for a fermion represented by an Octonion O basis element to go from point A to point B:

1 - A and B are both in M4: First Generation Fermion whose path can be represented by the single O basis element so that First Generation Fermions are represented by Octonions O.

2 - Either A or B, but not both, is in CP2: Second Generation Fermion whose path must be augmented by one projection from CP2 to M4, which projection can be represented by a second O basis element so that Second Generation Fermions are represented by Octonion Pairs OxO.

3 - Both A and B are in CP2: Third Generation Fermion whose path must be augmented by two projections from CP2 to M4, which projections can be represented by a second O and a third O, so that Third Generation Fermions are represented by Octonion Triples OxOxO.
3 Generation Fermion Combinatorics

First Generation (8)

(geometric representation of Octonions is from arXiv 1010.2979)

<table>
<thead>
<tr>
<th>electron</th>
<th>red up quark</th>
<th>green up quark</th>
<th>blue up quark</th>
<th>red down quark</th>
<th>green down quark</th>
<th>blue down quark</th>
<th>neutrino</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>I</td>
<td>J</td>
<td>K</td>
<td>i</td>
<td>j</td>
<td>k</td>
<td>1</td>
</tr>
</tbody>
</table>

Second Generation (64)

Mu Neutrino (1)

Rule: a Pair belongs to the Mu Neutrino if:
All elements are Colorless (black)
and all elements are Associative
(that is, is 1 which is the only Colorless Associative element).
Muon (3)
Rule: a Pair belongs to the Muon if:
All elements are Colorless (black)
and at least one element is NonAssociative
(that is, is E which is the only Colorless NonAssociative element).

Blue Strange Quark (3)
Rule: a Pair belongs to the Blue Strange Quark if:
There is at least one Blue element and the other element is Blue or Colorless (black)
and all elements are Associative (that is, is either 1 or i or j or k).

Blue Charm Quark (17)
Rules: a Pair belongs to the Blue Charm Quark if:
1 - There is at least one Blue element and the other element is Blue or Colorless (black)
and at least one element is NonAssociative (that is, is either E or I or J or K)
2 - There is one Red element and one Green element (Red x Green = Blue).

( Red and Green Strange and Charm Quarks follow similar rules )
Third Generation (512)

Tau Neutrino (1)
Rule: a Triple belongs to the Tau Neutrino if:
All elements are Colorless (black)
and all elements are Associative
(that is, is 1 which is the only Colorless Associative element)

Tauon (7)
Rule: a Triple belongs to the Tauon if:
All elements are Colorless (black)
and at least one element is NonAssociative (that is, is E which is the only Colorless NonAssociative element)
Blue Beauty Quark (7)
Rule: a Triple belongs to the Blue Beauty Quark if:
There is at least one Blue element and all other elements are Blue or Colorless (black)
and all elements are Associative (that is, is either 1 or i or j or k).

Blue Truth Quark (161)
Rules: a Triple belongs to the Blue Truth Quark if:
1 - There is at least one Blue element and all other elements are Blue or Colorless (black)
   and at least one element is NonAssociative (that is, is either E or I or J or K)
2 - There is one Red element and one Green element and the other element is Colorless (Red x Green = Blue)
3 - The Triple has one element each that is Red, Green, or Blue,
in which case the color of the Third element (for Third Generation) is determinative
   and must be Blue.

( Red and Green Beauty and Truth Quarks follow similar rules )
Fermion masses are calculated as a product of four factors:

\[ V(Q_{\text{fermion}}) \times N(\text{Graviton}) \times N(\text{octonion}) \times \text{Sym} \]

The ratio of the down quark spinor manifold volume factor to the electron spinor manifold volume factor is

\[ \frac{V(Q_{\text{down quark}})}{V(Q_{\text{electron}})} = \frac{V(S^7 \times \text{RP}^1)}{1} = \frac{\pi^5}{3}. \]

The third generation fermion particles correspond to triples of octonions. There are \(8^3 = 512\) such triples. The triple \(\{1,1,1\}\) corresponds to the tau-neutrino. The other 7 triples involving only 1 and E correspond to the tauon:

\[ \{E, E, E\} \{E, E, 1\} \{E, 1, E\} \{E, E\} \{1, 1, E\} \{1, E, 1\} \{E, 1, 1\} \]

The symmetry of the 7 tauon triples is the same as the symmetry of the first generation tree-level-massive fermions, 3 down quarks, the 3 up quarks, and the electron, so by the Sym factor, the tauon mass should be the same as the sum of the masses of the first generation massive fermion particles. Therefore the **tauon mass is calculated at tree level as \(1.877\) GeV.**

The beauty quark corresponds to 21 triples. They are triples of the same form as the 7 tauon triples involving 1 and E, but for 1 and I, 1 and J, and 1 and K = red, green, and blue beauty quarks. The seven red beauty quark triples correspond to the seven tauon triples, except that the beauty quark interacts with 6 Spin(0,5) gravitons while the tauon interacts with only two. The red beauty quark constituent mass should be the **red beauty quark mass** times the third generation graviton factor \(6/2 = 3\), so the **red beauty quark mass** is \(m_b = 5.63111\) GeV.

Triples of the type \(\{1, I, J\}, \{I, J, K\}, \text{etc.},\) do not correspond to the beauty quark, but to the truth quark. The truth quark corresponds to those 512 - 1 - 7 - 21 = 483 triples, so the constituent mass of the red truth quark is \(161 / 7 = 23\) times the red beauty quark mass, and the **red T-quark mass** is \(m_t = 129.5155\) GeV.
248-dim E8 contains 120-dim D8

\[ E8 / D8 = 64 + 64 \text{ Fermions} \]

\[ D8 / D4 \times D4 = 64 \text{ Spacetime} \]

\[ D4 = 28 \text{ Standard Model (12)} \]
\[ \text{with 16 Gravity + Dark Energy Ghosts} \]

\[ D4 = 28 \text{ Gravity + Dark Energy (16)} \]
\[ \text{with 12 Standard Model Ghosts} \]
The 24 Orange Root Vectors of the D4 of E8 Standard Model + Gravity Ghosts are on the Horizontal X-axis.

8 of them in the Orange Box represent the 8 Root Vectors of the Standard Model Gauge Groups SU(3) SU(2) U(1).
Their 4 Cartan Subalgebra elements correspond to the 4 Cartan Subalgebra elements of D4 of E8 Standard Model + Gravity Ghosts and to half of the 8 Cartan Subalgebra elements of E8.

The other 24-8 = 16 Orange Root Vectors represent Ghosts of 16D U(2,2) which contains the Conformal Group SU(2,2) = Spin(2,4) that produces Gravity + Dark Energy by the MacDowell-Mansouri mechanism.

Standard Model Gauge groups come from CP2 = SU(3) / SU(2) x U(1) (as described by Barkle in Gras. Quantum Grav. 3 (1986) L99-L105)

Electroweak SU(2) x U(1) is gauge group as Isotropy group of CP2.

SU(3) is global symmetry group of CP2 but due to Kaluza-Klein M4 x CP2 structure of compact CP2 at every M4 spacetime point, it acts as Color gauge group with respect to M4.
The 24 Yellow Root Vectors of the D4 of E8 Gravity + Standard Model Ghosts are on the Vertical Y-axis.
12 of them in the Yellow Box represent the 12 Root Vectors of the Conformal Gauge Group $SU(2,2) = Spin(2,4)$ of Conformal Gravity + Dark Energy.
The 4 Cartan Subalgebra elements of $SU(2,2) \times U(1) = U(2,2)$ correspond to the 4 Cartan Subalgebra elements of D4 of E8 Gravity + Standard Model Ghosts and to the other half of the 8 Cartan Subalgebra elements of E8.

The other $24-12 = 12$ Yellow Root Vectors represent Ghosts of 12D Standard Model whose Gauge Groups are $SU(3) \times SU(2) \times U(1)$.

Gravity and Dark Energy come from its Conformal Subgroup $SU(2,2) = Spin(2,4)$
(see Appendix - Details of Conformal Gravity and ratio DE : DM : OM)

$SU(2,2) = Spin(2,4)$ has 15 generators:

1 Dilation representing Higgs Ordinary Matter

4 Translations representing Primordial Black Hole Dark Matter

10 = 4 Special Conformal + 6 Lorentz representing Dark Energy
(see Irving Ezra Segal, "Mathematical Cosmology and Extragalactic Astronomy" (Academic 1976))

The basic ratio Dark Energy : Dark Matter : Ordinary Matter = 10:4:1 = 0.67 : 0.27 : 0.06
When the dynamics of our expanding universe are taken into account, the ratio is calculated to be $0.76 : 0.21 : 0.04$
The force strength of a given force is
\[
(1 / M_{\text{force}}^2 \times (\text{Vol}(\text{MISTforce})) \times (\text{Vol}(\text{Qforce}) \times \text{Vol}(\text{Dforce}))^{1 / m_{\text{force}}})
\]
where:
- \(M_{\text{force}}\) represents the effective mass;
- \(\text{Vol}(\text{MISTforce})\) stands for volume of MISforce and is sometimes also denoted by \(\text{Vol}(M)\);
- \(\text{Vol}(\text{Qforce})\) stands for volume of Qforce;
- \(\text{Vol}(\text{Dforce})\) stands for the complex bounded homogeneous domain of which Qforce is the Shilov boundary;
- \(m_{\text{force}}\) is the dimensionality of Qforce, which is \(\text{Vol}(\text{Dforce})^{1 / m_{\text{force}}}\) stands for a dimensional normalization factor (to reconcile the dimensionality of the Internal Symmetry Space of the target vertex with the dimensionality of the link from the origin to the target vertex).

Qforce, Hermitian symmetric space, Dforce, mforce, and \(\text{Vol}(\text{Dforce})\) for four forces are:

<table>
<thead>
<tr>
<th>Force</th>
<th>(M)</th>
<th>(\text{Vol}(M))</th>
<th>(Q)</th>
<th>(\text{Vol}(Q))</th>
<th>(D)</th>
<th>(\text{Vol}(D))</th>
</tr>
</thead>
<tbody>
<tr>
<td>gravity</td>
<td>(S^4)</td>
<td>(8\pi^2/3)</td>
<td>(\text{RP}^1\times S^4)</td>
<td>(8\pi^3/3)</td>
<td>(\text{IV}5)</td>
<td>(\pi^5/2^4\times 5!)</td>
</tr>
<tr>
<td>color</td>
<td>(\text{CP}^2)</td>
<td>(8\pi^2/3)</td>
<td>(\text{RP}^1\times S^4)</td>
<td>(8\pi^3/3)</td>
<td>(\text{IV}5)</td>
<td>(\pi^5/2^4\times 5!)</td>
</tr>
<tr>
<td>Weak</td>
<td>(S^2\times S^2)</td>
<td>(2\times 4\pi)</td>
<td>(\text{RP}^1\times S^4)</td>
<td>(4\pi^2)</td>
<td>(\text{IV}3)</td>
<td>(\pi^3/2^4)</td>
</tr>
<tr>
<td>e-mag</td>
<td>(T^4)</td>
<td>(4\times 2\pi)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The relative force strengths at the characteristic energy level of each force are:
- **Spin(5) gravity** at 10^{19} GeV = 1 ; \(G\text{Gmproton}^2\) approx 5 \times 10^{-39}
  - **SU(3) color** at 245 MeV = 0.6286
    - at 5.3 GeV = 0.166
    - at 34 GeV = 0.121
    - at 91 GeV = 0.106 ; with nonperturbative effects = 0.125
- **SU(2) weak** at 100 GeV = 0.2535 ; \(G\text{Wmproton}^2\) approx 1.05 \times 10^{-5}
- **U(1) e-mag** at 4 KeV = 1/137.03608
Fermion masses are calculated as a product of four factors:
\[ V(Q_{\text{fermion}}) \times N(G_{\text{Graviton}}) \times N(\text{octonion}) \times \text{Sym} \]

The ratio of the down quark spinor manifold volume factor to the electron spinor manifold volume factor is
\[ \frac{V(Q_{\text{down quark}})}{V(Q_{\text{electron}})} = \frac{V(S^7 \times RP^1)}{1} = \pi^5 / 3. \]

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The beauty quark corresponds to 21 triples.
They are triples of the same form as the 7 tauon triples involving 1 and E, but for 1 and I, 1 and J, and 1 and K, which correspond to the red, green, and blue beauty quarks, triples of the type \( \{1, I, J\} \), \( \{I, J, K\} \), etc., do not correspond to the beauty quark, but to the Truth quark.
The Truth quark corresponds to those \( 512 - 1 - 7 - 21 = 483 \) triples, so the constituent mass of red truth quark is \( 161 / 7 = 23 \) times red beauty quark.
red Truth quark mass is \( m_t = 129.5155 \text{ GeV} \).
Here is a summary of E8 Physics model calculation results. Since ratios are calculated, values for one particle mass and one force strength are assumed. Quark masses are constituent masses. Most of the calculations are tree-level, so more detailed calculations might be even closer to observations.

**Dark Energy : Dark Matter : Ordinary Matter = 0.75 : 0.21 : 0.04**

**Fermions as Schwinger Sources have geometry of Complex Bounded Domains with Kerr-Newman Black Hole structure size about 10^(-24) cm.**

<table>
<thead>
<tr>
<th>Particle/Force</th>
<th>Tree-Level</th>
<th>Higher-Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>e-neutrino</td>
<td>0</td>
<td>0 for nu_1</td>
</tr>
<tr>
<td>mu-neutrino</td>
<td>0</td>
<td>9 x 10^(-3) eV for nu_2</td>
</tr>
<tr>
<td>tau-neutrino</td>
<td>0</td>
<td>5.4 x 10^(-2) eV for nu_3</td>
</tr>
<tr>
<td>electron</td>
<td>0.5110 MeV</td>
<td></td>
</tr>
<tr>
<td>down quark</td>
<td>312.8 MeV</td>
<td>charged pion = 139 MeV</td>
</tr>
<tr>
<td>up quark</td>
<td>312.8 MeV</td>
<td>proton = 938.25 MeV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>neutron - proton = 1.1 MeV</td>
</tr>
<tr>
<td>muon</td>
<td>104.8 MeV</td>
<td>106.2 MeV</td>
</tr>
<tr>
<td>strange quark</td>
<td>625 MeV</td>
<td></td>
</tr>
<tr>
<td>charm quark</td>
<td>2090 MeV</td>
<td></td>
</tr>
<tr>
<td>tauon</td>
<td>1.88 GeV</td>
<td></td>
</tr>
<tr>
<td>beauty quark</td>
<td>5.63 GeV</td>
<td></td>
</tr>
<tr>
<td>truth quark (low state)</td>
<td>130 GeV</td>
<td>(middle state) 174 GeV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(high state) 218 GeV</td>
</tr>
<tr>
<td>W⁺</td>
<td>80.326 GeV</td>
<td></td>
</tr>
<tr>
<td>W⁻</td>
<td>80.326 GeV</td>
<td></td>
</tr>
<tr>
<td>W₀</td>
<td>98.379 GeV</td>
<td>20 = 91.862 GeV</td>
</tr>
</tbody>
</table>

**M_{planck} 1.217x10^19 GeV**

- Higgs VEV (assumed) 252.5 GeV
- Higgs (low state) 126 GeV (middle state) 182 GeV (high state) 239 GeV
- Gravity Gg (assumed) 1
  \((Gg)(M_{proton}^{-2} / M_{planck}^{-2}) = 5 \times 10^{-39}\)
- EM fine structure 1/137.03608
- Weak Gw 0.2535
- Gw\((M_{proton}^{-2} / (M_{W^+}^{-2} + M_{W^-}^{-2} + M_{Z^0}^{-2})) = 1.05 \times 10^{-5}\)
- Color Force at 0.245 GeV 0.6286 0.106 at 91 GeV

Kobayashi-Maskawa parameters for W⁺ and W⁻ processes are:

\[
\begin{array}{ccc}
  d & s & b \\
  u & 0.975 & 0.222 & 0.00249 & -0.00388i \\
  c & -0.222 & -0.000161i & 0.974 & -0.0000365i & 0.0423 \\
  t & 0.00698 & -0.00378i & -0.0418 & -0.00086i & 0.999 \\
\end{array}
\]

The phase angle d13 is taken to be 1 radian.
E8 = H4 + H4 = 120 + 120 = 240-vertex Witten polytope tiling of 8-dim space

E8 = 120 BiVectors + 128 half-Spinors of Cl(16) Clifford Algebra
with graded structure
1 16 120 560 1820 4368 8008 11440 12870 11440 8008 4368 1820 560 120 16 1
By 8-Periodicity of Real Clifford Algebras: Cl(16) = tensor product Cl(8) x Cl(8)
so with that product E8 = F4 x F4

H4 = 24 (vertices) + 96 (edges) = 120-vertex 600-cell tiling of 4-dim space
with Coxeter Group determined by E8
**F4 = 24 cell + dual 24-cell tiling of 4-dim space**

F4 = 8 Vectors + 28 BiVectors + 16 Spinors of Cl(8) Clifford Algebra  
with graded structure 1 8 28 56 70 56 28 8 1  
tile 4-dim space by 24-cells and their dual 24-cells

**D4 24-cell tiling of 4-dim space**

D4 = 28 BiVectors of Cl(8) Clifford Algebra with 24 root vectors  
with graded structure 1 8 28 56 70 56 28 8 1  
tile 4-dim space by 24-cells

**A3 = D3 = cuboctahedral tiling of 3-dim space**

A3=D3 = 15 BiVectors of Cl(6) Clifford Algebra with 12 root vectors and  
with graded structure 1 6 15 20 15 6 1  
tile 3-dim space by cuboctahedra  
which can be seen as a central part of a 24-cell (green vertices above)

**H3 = 12-Vertex Icosahedron as Jitterbug Transform of 12-Vertex Cuboctahedron**

with Coxeter Group determined by D6
H2 Penrose STAR tilings of 2-dim space

\[ \text{H2} = I^{5 \_2} = \text{Penrose STAR tiling of 2-dim space} \]

with Coxeter group determined by A4 which contains A2 and field extension \( \mathbb{Q}(\sqrt{5}) \)

The central part of the tiling has 5 pentagonal sectors

Each of the 5 pentagonal sectors of the tiling contains a 2-dim projected version of the 8-dim E8 Root Vector structure of E8 Physics corresponding to the Complex E6 subalgebra of Octonionic E8. The outer boundary of each sector is not a straight line but is curved with Conformal Symmetry and pentagonal sectors further out are conformally curved rather than straight-line pentagons.

Each pentagonal sector represents the Complex part of Octonionic E8 Physics whose 240 E8 Root Vectors project to the 72 Root Vectors of E6 subalgebra of E8 which 72 E6 Root Vectors have the following physical interpretation:

- 16 = 2x8 of which represent Complex Fermion Particles
- 16 = 2x8 of which represent Complex Fermion AntiParticles
- 16 = 2x(4+4) of which represent Complex (4+4)-dim Kaluza-Klein SpaceTime
- 12 of which represent the Standard Model
- 12 of which represent Gravity + Dark Energy

as shown in the following image of one of the pentagonal sectors:
The Bohm Quantum Potential interacts between two Pentagonal Sectors by 24 Bohm Carrier Tiles of one Pentagonal Sector carrying E8 Configuration Information and comparing it with 24 Bohm Carrier Tiles of the Other Sector carrying E8 Configuration Information. If the resulting 24 x 24 Matrix shows that the two E8 Configurations are similar, then a Bohm Quantum Potential Resonant Connection is established.

The Bohm Quantum Potential 24x24 Matrix is traceless because Configuration Resonance is sensitive to similarity rather than dilation scale and is symmetric because Configuration Resonance is symmetric between Sectors.
Robert de Marras said "... 256 ... 2^8 ions Voudons ..." Moreno ... determines that the automorphism group of the ZD's of all 2^n-ions ... obey a simple pattern: for n ≥ 4 this group has the form G2 x S3 x S3 (order 6 permutation group on 3 elements). This says the automorphism group of the Sedenions' ZD's has order 14 x 1 x 6 = 84 ... based on 7 octahedral lattices ("Box-Kites") ...
1 + 8 + 28 + 56 + (35 + 35) + 56 + 28 + 8 + 1
56-dim Fr3(0)
52-dim F4 of CP2 in 256-dim Cl(8)

F4 / B4 = OP2 = Spinor Fermions = 8 Particles + 8 AntiParticles
B4 / D4 = 8-dim SpaceTime = Kaluza-Klein M4 x CP2
D4 = Spin(8) contains Spin(6) = SU(4) contains SU(3) Color Force
SU(3) Color Force = Global Symmetry of CP2 = SU(3) x SU(2) x U(1)
SU(2) x U(1) ElectroWeak Force = Local Symmetry of CP2

52-dim F4 of Cn6 -> M4 in 256-dim Cl(8)

E8 Kaluza-Klein (Cn6 -> M4) x CP2
In (Cl(8) of CP2) x (Cl(8) of Cn6 -> M4) = Cl(16) containing E8
at each of the 256 points of Cl(6) of Cn6 -> M4 there are all 256 points of Cl(6) of CP2
D8 = Cl(16) BiVectors = 120
E8 / D8 = 128-dim Fermion Spinor Space = 8 components of 8x8 Fermions
D8 / D4 = D4 x D4 = A7+1 = 64 = 8-dim position x 8-dim momentum
D4 containing D3 = Spin(2,4) = A3 = SU(2,2) for Conformal Gravity + Dark Energy
D4 containing D3 = SU(4) containing Color Force SU(3)
10xFr3(O) = Cl(16) TriVectors = 560
Void $\rightarrow$ Cl(0) $\rightarrow$ Cl(1) $\rightarrow$ Cl(2) $\rightarrow$ Cl(4) $\rightarrow$ Cl(16)

Kaluza-Klein Spacetime
$M_4 \times CP^2$

Cl(8) that contains $2^8 \times D_4$ for
M4 Gravity

| Cl(8) that contains $2^8 \times D_4$ for
M4 Gravity | Cl(8) that contains $2^8 \times D_4$ for
CP2 Std Model |
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<tbody>
<tr>
<td>1</td>
<td>16</td>
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<tr>
<td>8</td>
<td>1</td>
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<tr>
<td>28</td>
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<td>70 x 70</td>
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<tr>
<td>4368</td>
<td>16</td>
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</table>

Cl(8) x Cl(8) = Cl(16)

Spinors: $(8_s \cdot 8_c) \rightarrow (8_s \cdot 8_c)$

Cl(0, 16) x Cl(0, 8) = Cl(0, 24)

$M(2, Cl(0, 24)) = Cl(1, 25)$

Completion of Union of All Tensor Products of Cl(1,25) = AQFT