Cl(16) - E8 - Fr3(O) - Cl(1,25) Physics - Straight OUTTA AFRICA

Frank Dodd (Tony) Smith, Jr. - 2018

Abstract

Cl(16) - E8 - Fr3(O) - Cl(1,25) Physics of viXra 1807.0166 and 1804.0121 comes from Ancient Africa. National Geographic Genographic Y-DNA project shows humans first arrived from Central Africa at Giza and Angkor approximately 38,000 years ago. Giza Pyramids and Sphinx and Angkor Temples are aligned with Precession Star Positions of that time. Since the Precession Period is about 26,000 years, those same Star Positions would have occurred also about 12,000 years ago. My view is that there is no evidence that humans of 12,000 years ago had more construction ability than those of 38,000 years ago. and that the Giza Pyramids and Sphinx and Angkor Temples were initially built by the first humans to arrive there from Central Africa about 38,000 years ago.

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Straight OUTTA AFRICA

60,000 years ago Humans were all living in Central Africa
where they learned IFA, Real Clifford Algebras, and Cellular Automata
By about 38,000 years ago Humans had migrated as far as Giza and Angkor
where we now see
Giza Pyramids and Sphinx with geometry of Cl(16) and E8 and
Astronomical Orientation for Vega North Star
and
Angkor Temple geometry of Cl(16) and Fr3(O) and
Rig Veda structure of E8 Root Vectors and
Astronomical Orientation for Draco and Vega North Star

By Earth's Precession of Equinox period of 26,000 years,
Vega as North Star 38,000 years ago would also occur at 12,000 years ago.

Manetho, historian for Ptolemy I who was General for Alexander the Great,
produced a Calendar of Human History with roughly consistent dates:
(here, to me, "roughly" = +/- 2160 years = precession time of sun in one of 12 zodiac constellations)

36,525 years ago - Rule of Gods - North Star Vega - Geminga Shock - Glaciation
22,625 years ago - Rule of Demigods - last Glacial Maximum
17,413 years ago - Rule of Spirits of the Dead - end of last Glacial Maximum
11,600 years ago - Rule of Mortal Humans - North Star Vega - Vela X -
- Taurid/Encke comet fragmented - Ice Age ends

Could Humans of 38,000 years ago have built Giza Pyramids - Sphinx and Angkor Temples - Rig Veda ?

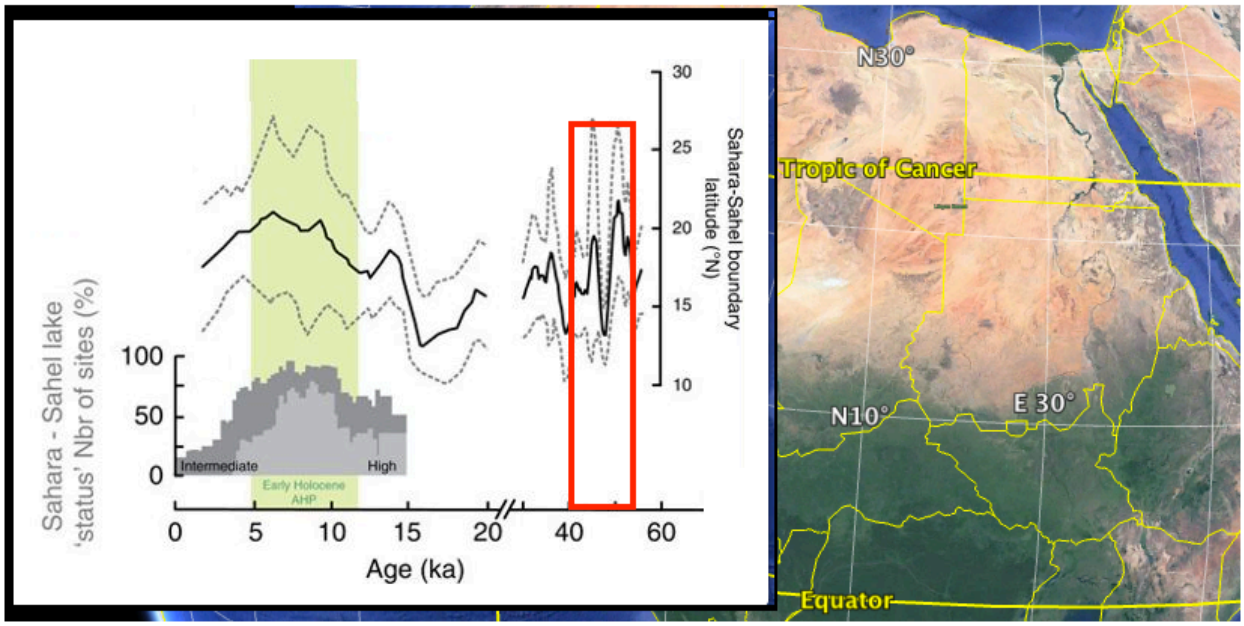
Humans of 38,000 years ago could have understood:

IFA - divination based on 16x16 = 256 Odu

Real Clifford Algebras = Algebra of Geometry of Vector Spaces with 8-Periodicity based on 256-dimensional Cl(8)

256 Elementary Cellular Automata

because those things are **abstract ideas created by mental power which can be enhanced by Soma**. Rig Veda Book 9 Hymn 4 says "... **Soma .. make us better than we are ... Win skillful strength and mental power ... Through thine own mental power and aid long may we look upon the Sun** ...".
According to the National Geographic Genographic project: "... Terence McKenna postulates that the most likely candidate for **soma is the mushroom Psilocybe cubensis**, a hallucinogenic mushroom that grows in cow dung ... the 9th mandala of the Rig Veda makes ... references to the cow as the embodiment of soma ...
It was around 50,000 years ago that the ice sheets of northern Europe began to melt, introducing a period of warmer temperatures and moister climate in Africa ...
As the drought-ridden desert changed to a savanna ... animals ...[such as cattle, in whose dung grew Psilocybin mushrooms,] expanded their range ...".
The savanna immediately south of the Sahara is known as the Sahel.
Cattle and Psilocybin / Soma were found south of the Sahara - Sahel boundary.
According to Nature Communications 6, Article number 8751 (2015) by Skonieczny et al,
"... the estimated latitudinal position of the ... Sahara-Sahel boundary [is] ...

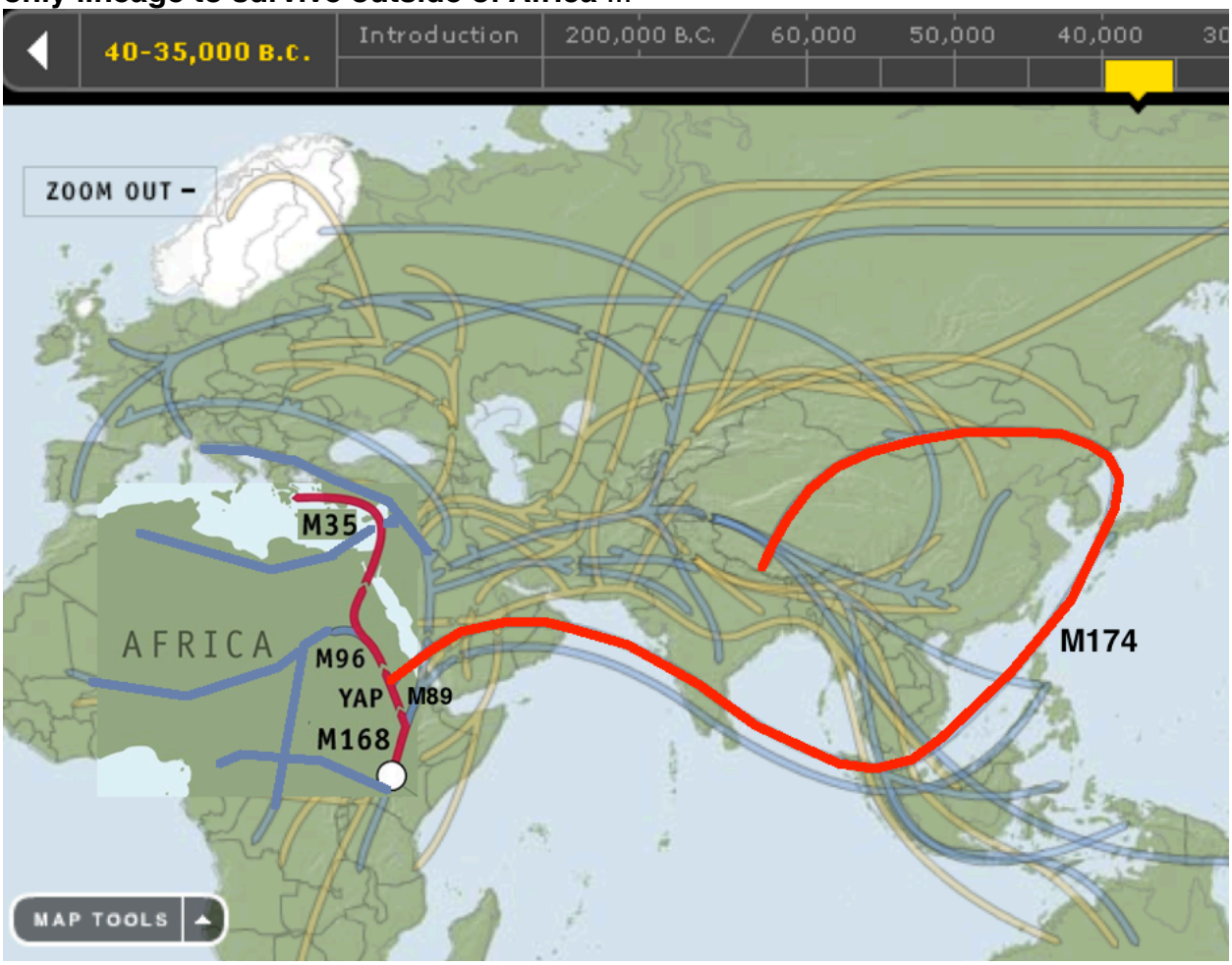


..." .
55,000 to 40,000 years ago (red box) Soma was abundant up to about 20 degrees north

so humans had thousands of years exposure to, and enlightenment from, Soma during which time they could have learned the mental constructs that are

IFA - divination based on 16x16 = 256 Odu
and
Real Clifford Algebras = Algebra of Geometry of Vector Spaces with 8-Periodicity based on 256-dimensional Cl(8)
and
256 Elementary Cellular Automata

The project describes Human migration from Africa:
"... descendants [of the] man who gave rise to **M168 Y-DNA lineage ... became the only lineage to survive outside of Africa** ...



... making him the common ancestor of every non-African man living today ...
He probably lived in northeast Africa in the region of the Rift Valley, perhaps in present-day Ethiopia, Kenya, or Tanzania, some 31,000 to 79,000 years ago. Scientists put the most likely date for when he lived at around 50,000 years ago. ...

[**M168 split into M89 and YAP**]:

M89 ... born around 50,000 years ago, head[ed] north [on the east side of the Red Sea, through Arabia]... Some 90 to 95 percent of all non-Africans today are descendants of ... M89 ...

YAP occurred around northeast Africa and i... is characterized by a mutational event known as an Alu insertion, a 300-nucleotide fragment of DNA which, on rare occasion, gets inserted into different parts of the human genome during cell replication. ...
Over time **this lineage split into two distinct groups**. ...

One ... is found in **Asia and defined by the *M174* mutation** ... [they]... followed the coastline of Africa through the southern Arabian Peninsula, India, Sri Lanka, and Southeast Asia ... later migration... carried ...[them]... north along
the East Asian Coast into Japan ...

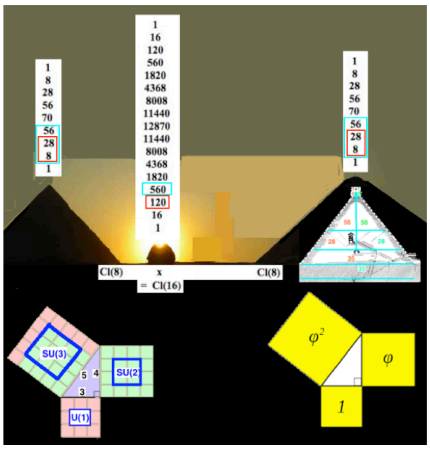
The other group ... is found primarily in Africa and the Mediterranean is defined by marker *M96*. ... [whose] lineage was born around 30,000 to 40,000 years ago in northeast Africa ...[they moved north along the Nile west of the Red Sea]... ".

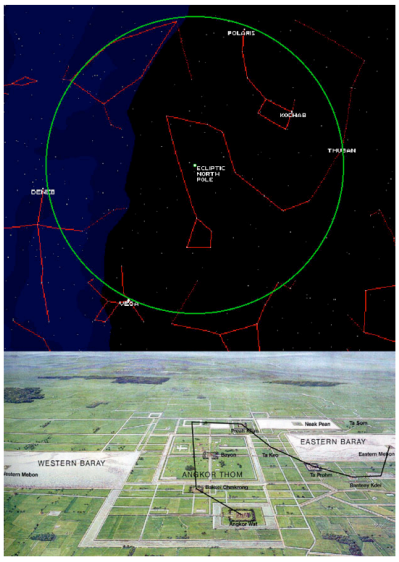
M96 reached Giza and M174 reached Angkor about 38,000 years ago, when, as the National Geographic Genographic project says, "... Beginning about 40,000 years ago, the climate shifted once again and became colder and more arid ...
for the next 20,000 years ... Drought hit Africa and the grasslands reverted to desert ...".

Realizing that they were geographically isolated from the Central African Homeland and that they would no longer have reliable access to Psilocybin / Soma
they decided to build physical structures and written documents to preserve
the Wisdom of Soma for future generations. Therefore:

38,000 years ago when Vega was North Star, Draco was over the Ecliptic North Pole, and the Geminga Supernova Shock Wave hit Earth

M96
Giza





M174
Angkor

M96 constructed Giza Pyramids and Sphinx with geometry of Cl(16) and E8 and Astronomical Orientation for Vega North Star as of 38,000 years ago

M174 constructed the Angkor Temples with geometry of Cl(16) and Fr3(O) and Astronomical Orientation for Draco and Vega North Star as of 38,000 years ago

M174 wrote the Rig Veda in Sanskrit with structure of E8 Root Vectors and 10-dimensional spacetime of 26D String = World-Line Theory of Fr3(O)

During the 26,000 year Precession Cycle after 38,000 years ago
there was decreasing access to Psilocybin / Soma and
Manetho's Rule of Gods ended and Rule of Demigods began around the time that
National Geographic Genographic said "... *M35*, was born around 20,000 years ago ...
His descendants were among the first farmers and helped spread agriculture ..."
During Manetho's Rule of the Demigods and Rule of the Spirits of the Dead

glaciation continued until about 12,000 when years ago
when Vega was again the North Star, the Vela X supernova exploded,
the Ice Age ended flooding the Sunda Shelf, the Persian Gulf, and the China Seas,
and Manetho's Rule of Mortal Humans began.
The Mortal Humans were immediately flooded out of a lot of productive land
of the Persian Gulf, the Sunda Shelf, and the China Seas
and so thrown into competition over more limited resources
leading to less cooperative behavior and more military competition
that continued through World War II (won by USA) to the present day
with expensive military and economic competition between USA, Russia, and China.

Will that competition lead to hugely destructive World War III or will USA, Russia, and China come to a harmonious cooperative agreement?

Terence McKenna (OMNI May 1993) said: "... From 75,000 to about 15,000 years ago,
there was a kind of human paradise on Earth. ... For [the last]10,000 years ...[with a
high level of competition and without psilocybin]...
we've pursued an agenda of beasts and demons [and] tooth-and-claw dominance ... .

If history ...[continues on the path of tooth-and-claw dominance]... the future ... will be
about scarcity, preservation of privilege, forced control of populations ...
If history [goes back to the old human harmonious cooperative paradise]...
then [what] lies ahead is a dimension of ... freedom and transcendence ...".

Giza Pyramids and Sphinx

36,000 Years Ago - National Geographic Genographic YDNA -
M168 - YAP - M96 - **M35 Humans follow North Star Vega up the Nile to Giza and Mediterranean**

This coincided with the beginning of Egyptian History according to Manetho (working under Alexander's General and sucessor Ptolemy I):
36,525 years ago - Rule of Gods - North Star Vega - Geminga Shock Wave - Glaciation
22,625 years ago - Rule of Demigods - last Glacial Maximum
17,413 years ago - Rule of Spirits of the Dead - end of last Glacial Maximum
11,600 years ago - Rule of Mortal Humans - North Star Vega - Vela X - end of Ice Age

When Humans reached Giza they built

two large Pyramids - each representing Cl(8)
whose 8 Vectors + 28 BiVectors + 16 Spinors = F4 Lie Algebra

one for F4gde = Conformal Gravity + Dark Energy

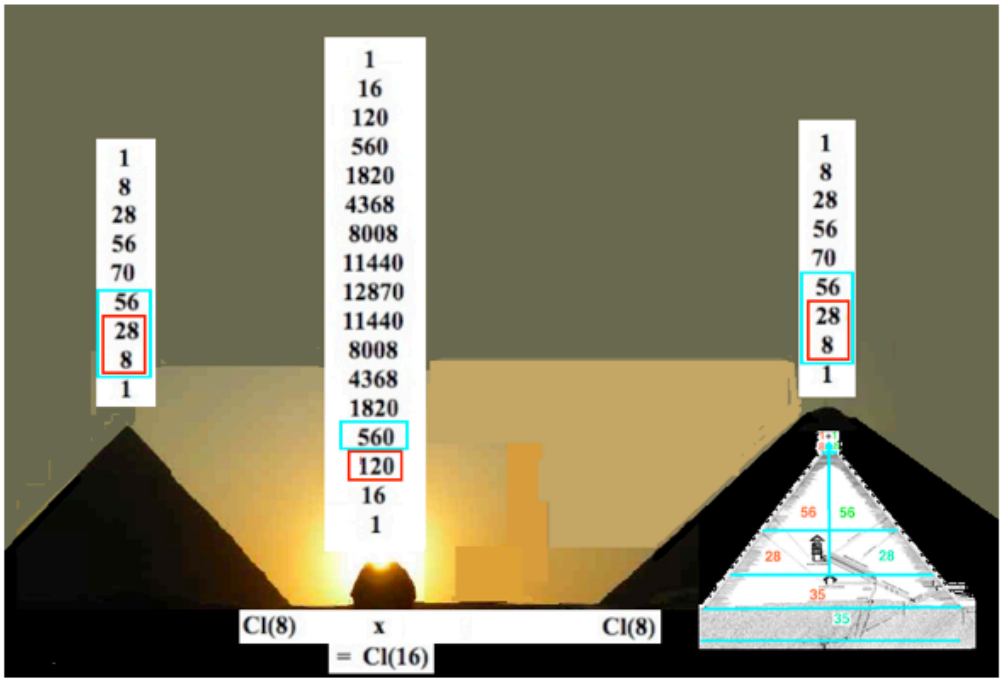
one for F4sm = Standard Model

and

the **Sphinx - representing Cl(16)**

whose 120 BiVectors + 128 half-Spinors = E8 = Lagrangian

whose 560 TriVectors = 10 copies of Fr3(O) = 26D World-Line-String Theory



Each Pyramid represented a copy of Cl(8) with graded structure

256 = 1 + 8 + 28 + 56 + 70 + 56 + 28 + 8 + 1 = (8L+8R) x (8L+8R)

so that each contained a copy of 56-dim Fr3(O)

and of 52-dim F4 = 8 + 28 + (8L+8R)

By 8-Periodicity of Real Clifford Algebras the tensor product **Cl(8) x Cl(8) = Cl(16)**

Cl(16) contains 10 copies of Fr3(O) = 1x56 + 8x28 + 28x8 + 56x1 = 560 elements

related to 26D World-Line=String Theory

Cl(16) contains (1x28 + 8x8 + 28x1 = 120) + (8Lx8L + 8Rx8R = 128) = 248-dim E8

248-dim E8 structure came from the F4gde and F4sm of the two Pyramids:

tensor product Cl(16) = Cl(8) x Cl(8)

induces the product

E8 = F4gde x F4sm

120-dim Cl(16) BiVectors = 1 x 28 + 8 x 8 + 28 x 1 of Cl(8) x Cl(8)

128-dim Cl(16) Half-Spinors = 8L x 8L + 8R x 8R of Cl(8) x Cl(8)

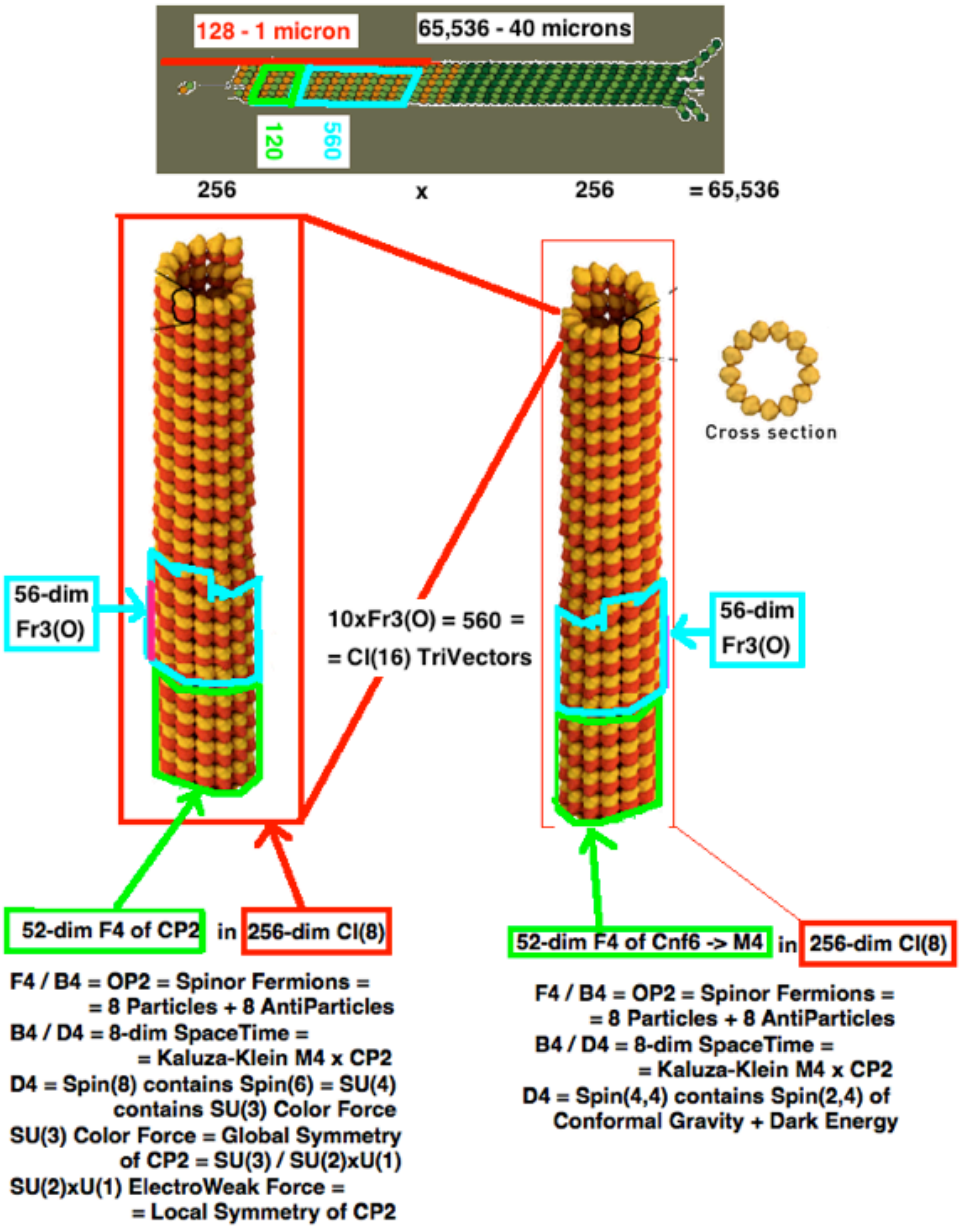
where 8L denotes left-handed Half-Spinors of Cl(8)

and 8R denotes right-handed Half-Spinors of Cl(8)

and

8Lx8L + 8Rx8R are the Half-Spinors of Cl(16) with consistent handed-ness structure.

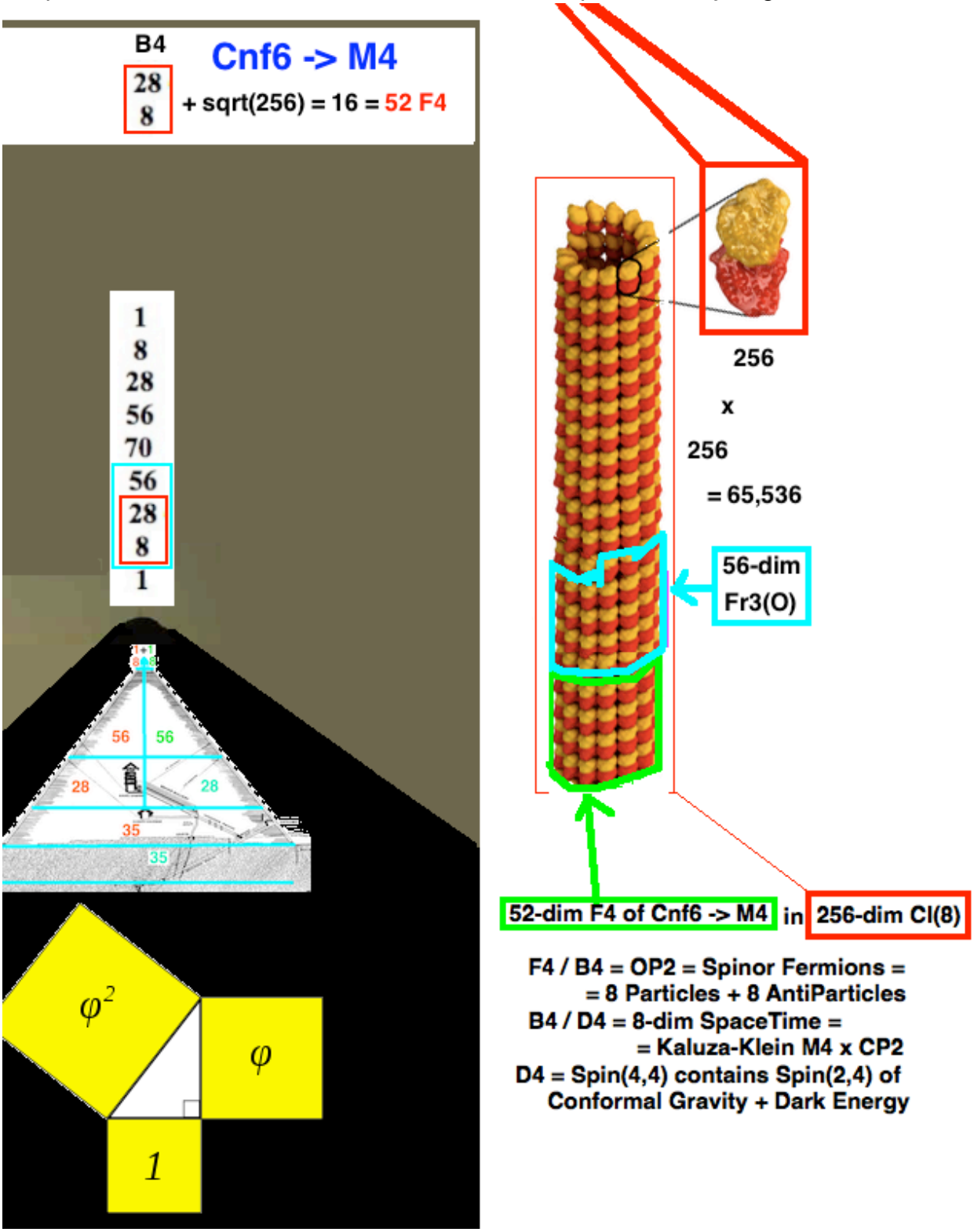
256-dim Cl(8) x 256-dim Cl(8) = 65,536-dim Cl(16) Clifford Algebra structure is also present in **Microtubules = 40 micron size aggregates of 65,536 tubulin dimers that are the basis of Penrose-Hameroff Bohm Potential Quantum Consciousness**.



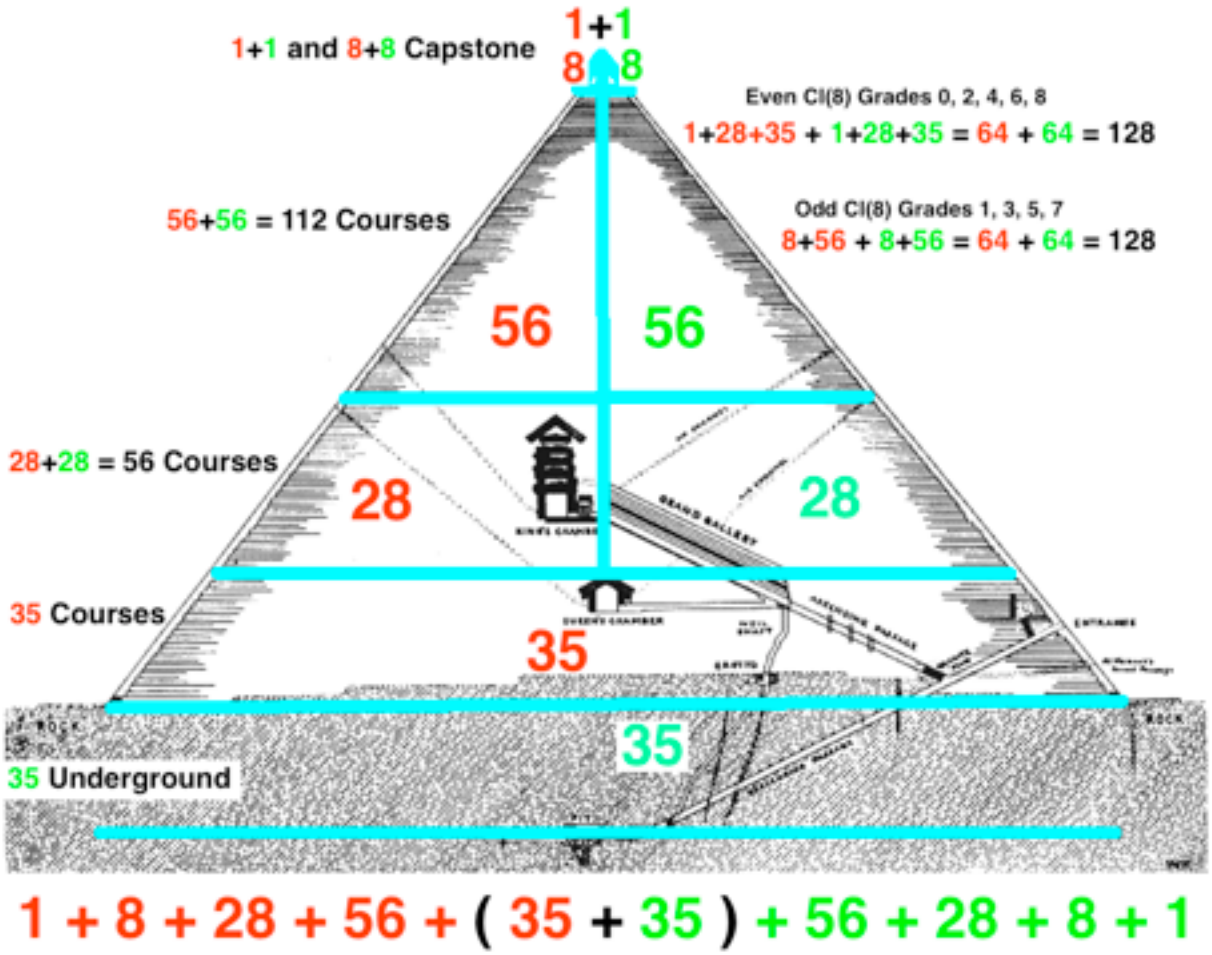
Assembly of 65,536 tubulins into a 40-micron microtubule can be seen to be analogous to the 256 x 256 tensor product Cl(8) x Cl(8) where
one 256-dim Cl8) represents Conformal Gravity+Dark Energy with F4gde related to the Minkowsi M4 of Kaluza-Klein M4 x CP2 and
the other Cl(8) represents Standard Model U(1) SU(2) SU(3) with F4sm related to the CP2 = SU(3) / SU(2)xU(1) of Kaluza-Klein M4 x CP2

The E8 and 10 copies of Fr3(O) of Cl(16) only use 248 + 560 of the 65,536 elements so that 64,728 Cl(16) elements are available for Quantum Consciousness thought processes

The Great Pyramid slope is of a Golden Ratio Right Triangle representing Conformal Gravity+Dark Energy with Gauge Group Spin(2,4) = SU(2,2)
It represents M4 of Kaluza-Klein M4 x CP2 and is represented by F4gde



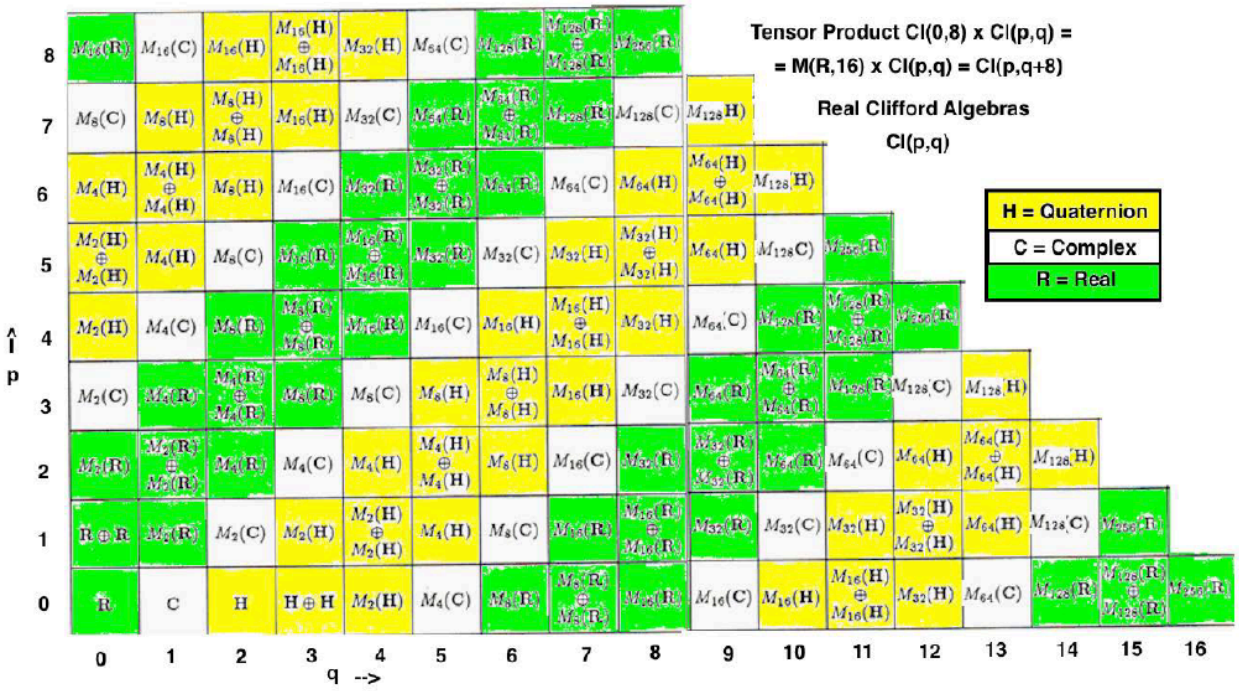
Clifford Algebras were not known to European mathematicians until Clifford in the 19th century and not known to European physicists until Dirac in the 20th century but it seems to me that their structure was known to Africans in ancient times. The courses of the Great Pyramid of Giza correspond to the graded structure of 256-dim Cl(8):



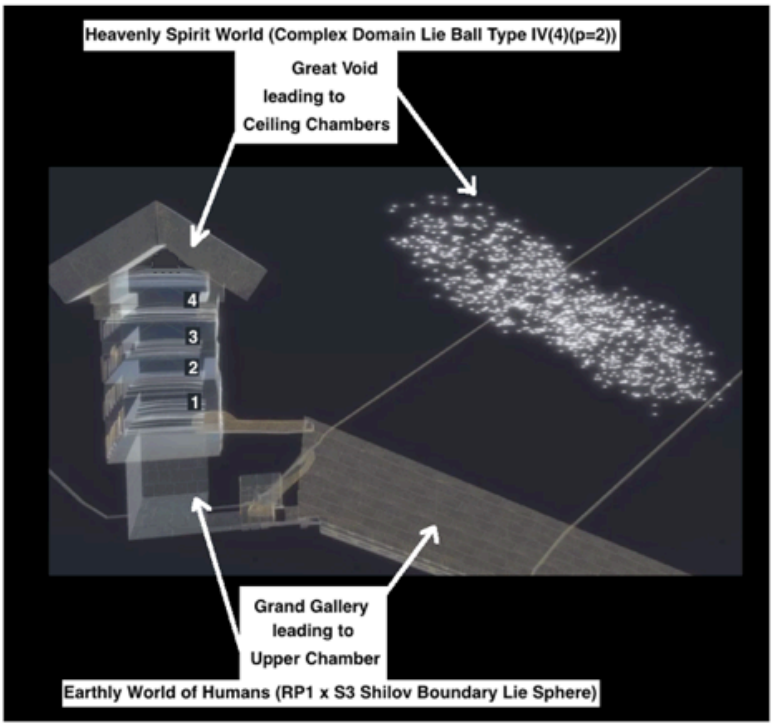
(image adapted from David Davidson image - for larger size see tony5m17h.net/GreatPyrCl8.png)

William KIngdon Clifford (1845 - 1879) described that 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.

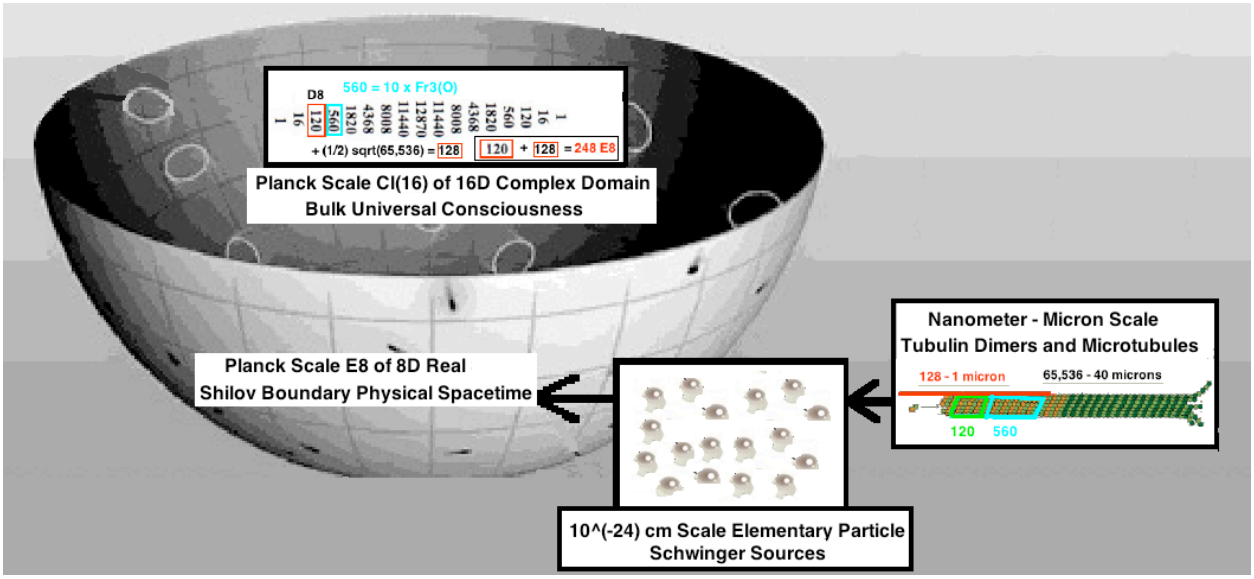
When matter takes the complex form of a living human brain,
the corresponding mind-stuff takes the form of a human consciousness ...".
(Wikipedia - (1878, "On the Nature of Things-in-Themselves", Mind, Vol. 3, No. 9, pp. 57–67))



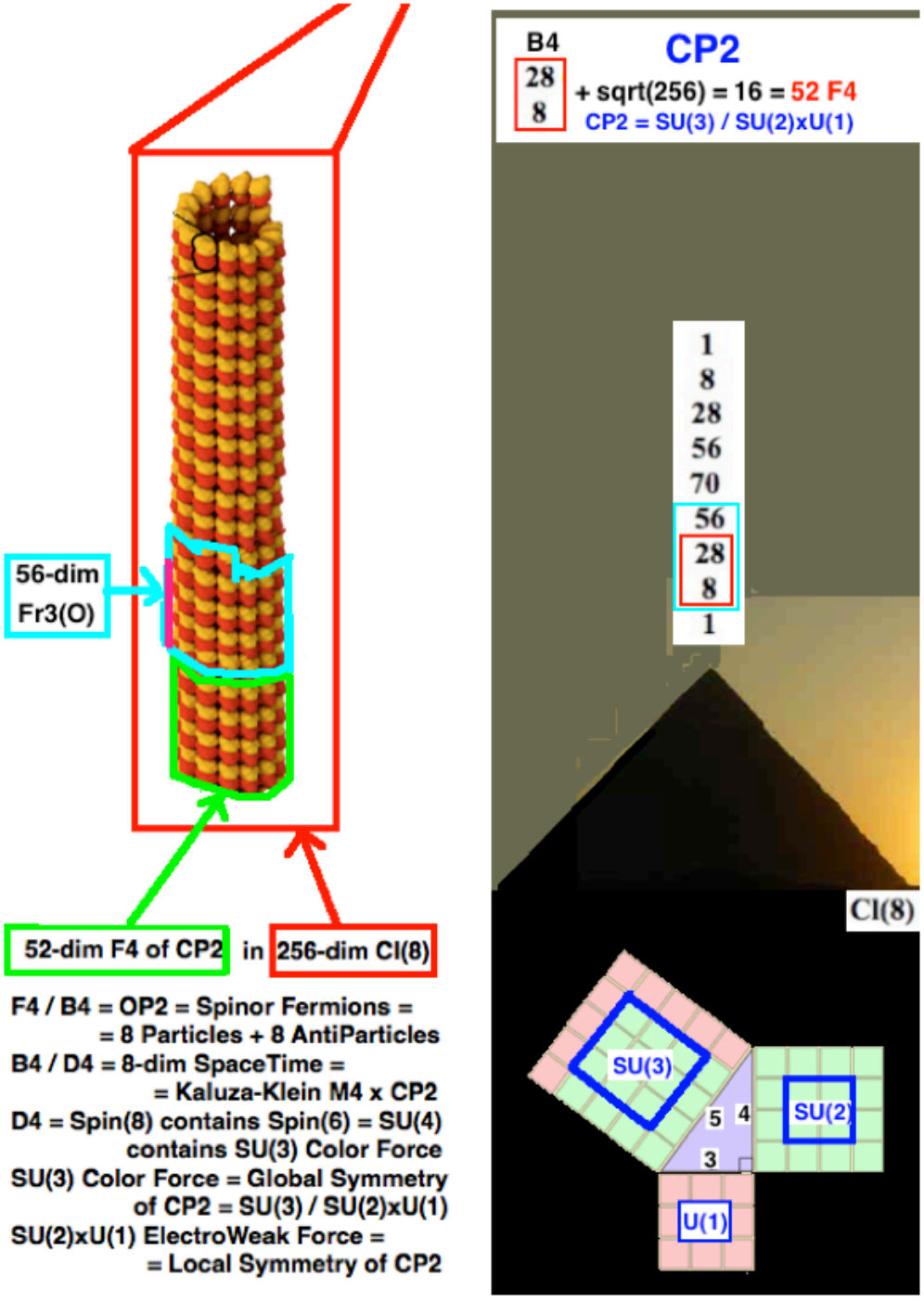
Above the Grand Gallery is a Great Void leading to Ceiling Chambers above the Upper Chamber - (image from ScanPyramids web site)



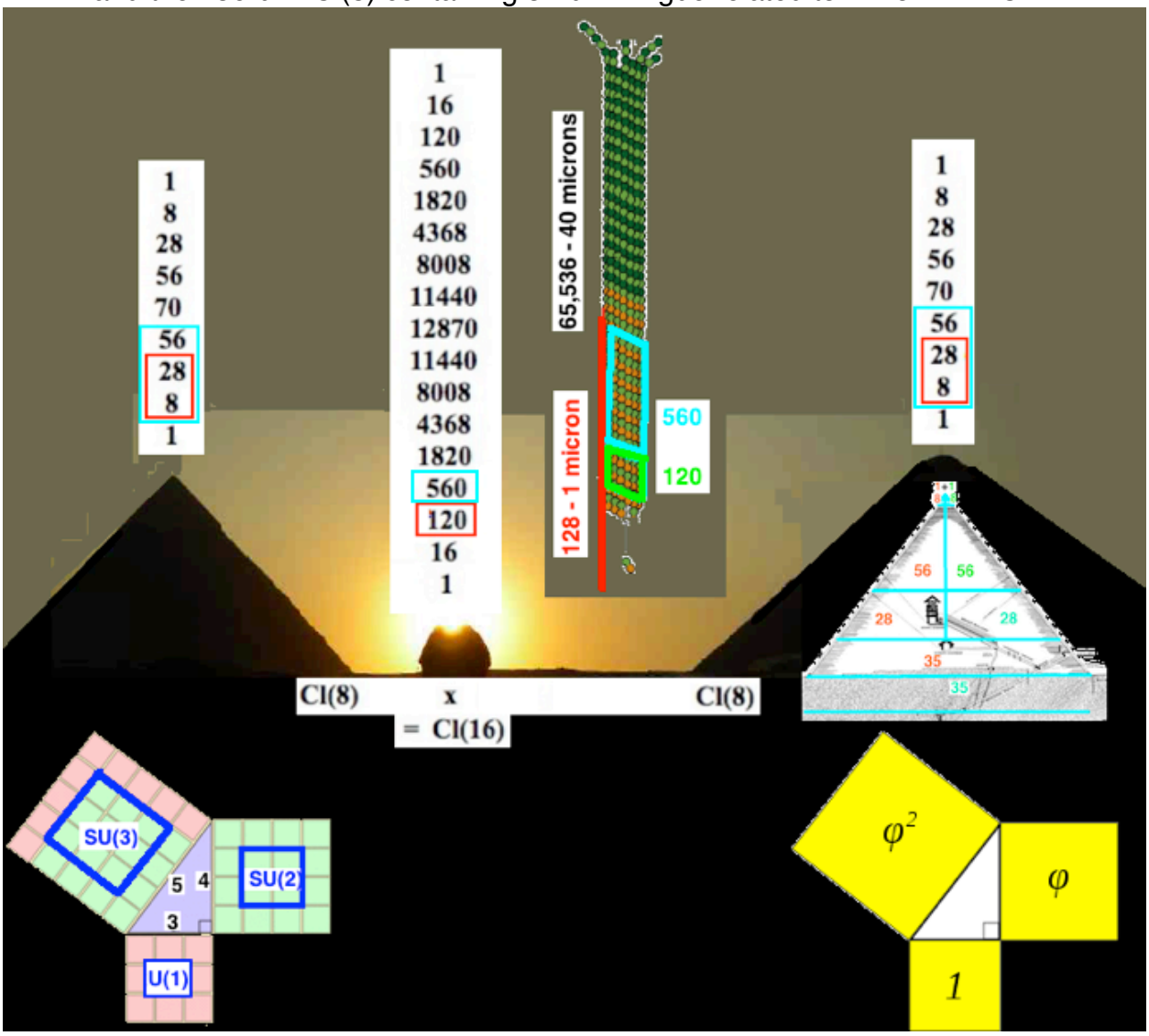
The Builders of the Great Pyramid represented the Real Shilov Boundary Physical world by the Grand Gallery and Upper Chamber that are easily accessible by Humans with Microtubule Quantum Consciousness and
they represented the Imaginary Complex World of Cl(16) Spacetime Cells mirroring the Human Microtubule World as Ceiling Chamber spaces and the Great Void that are more accessible to Souls of the Spirit World than to Physical Humans.



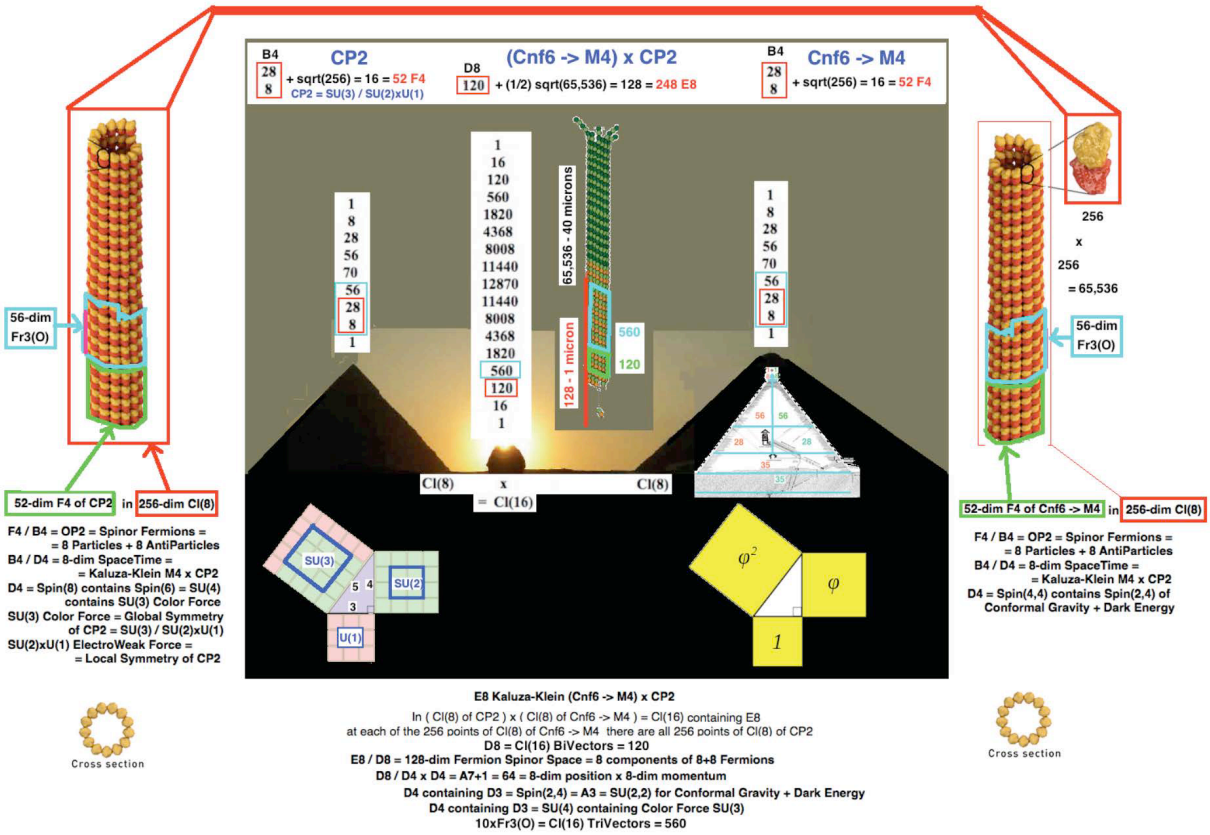
The Second Pyramid slope is of a 3-4-5 Right Triangle representing the Standard Model with Gauge Groups U(1) SU(2) SU(3) It represents CP2 of Kaluza-Klein M4 x CP2 and is represented by F4sm



The Sphinx represents 65,536-dim Cl(16) containing 248-dim E8
as the tensor product combination of
the 256-dim Cl(8) containing 52-dim F4sm related to CP2 of M4 x CP2
and the 256-dim Cl(8) containing 52-dim F4gde related to M4 of M4 x CP2



**The image on the following page summarizes how the Sphinx represents
the Cl(16) combination of the two large Cl(8) Pyramids
and also
the 65,536-element 40 micron Microtubules of Bohm Quantum Consciousness**



two large Pyramids - each representing Cl(8)
whose 8 Vectors + 28 BiVectors + 16 Spinors = F4 Lie Algebra

one for F4gde = Conformal Gravity + Dark Energy

one for F4sm = Standard Model

and

the **Sphinx - representing Cl(16)**

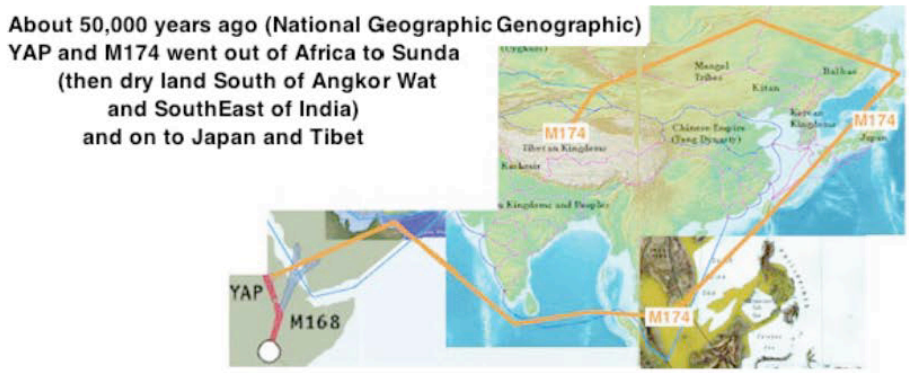
whose 120 BiVectors + 128 half-Spinors = E8 = Lagrangian

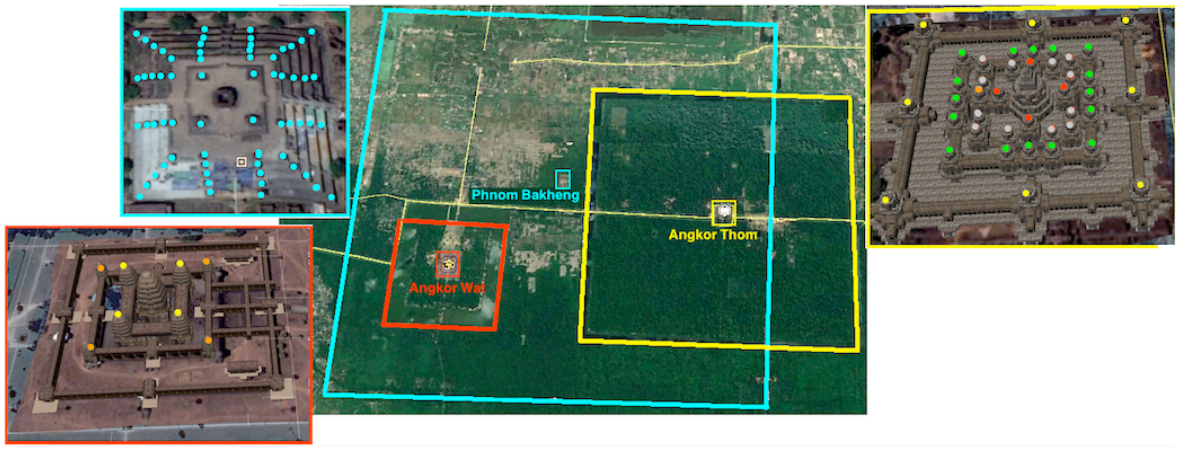
whose 560 TriVectors = 10 copies of Fr3(O) = 26D World-Line-String Theory

Angkor Temples and Rig Veda

African IFA = 16x16 = 2^8 = 256 Odu = 256 Elementary Cellular Automata = Cl(8)
Tensor Product Cl(8) x Cl(8) = Cl(16) which contains E8 and Fr3(O)

Rig Veda / Angkor Wat





Angkor Thom, Angkor Wat, Phnom Bakheng
<-->
Giza Great Pyramid Cl(8) (D4gde), Second Pyramid Cl(8) (D4sm), Sphinx Cl(16) (E8 + Fr3(O))

Angkor Thom: 8 yellow Outer Towers + 16 green Middle Towers = 24-dim OxOxO of Fr3(O) 26-D String=World-Line Theory
1 orange Inner Tower = Bohm Quantum Potential from Cl(16) TriVectors
4 red + 12 gray Inner Towers = Fundamental Lepton + Quark Particles / AntiParticles from Cl(16) half-Spinors

Angkor Wat: 4 yellow Inner Towers = 4-dim Minkowski Physical Spacetime of Kaluza-Klein M4 x CP2 from Cl(16) BiVectors
4 orange Middle Towers = 4-dim CP2 = SU(3) / SU(2) x U(1) of Kaluza-Klein M4 x CP2 from Cl(16) BiVectors

Phnom Bakheng: 64 cyan Towers = D8 / D4 x D4 = by Cl(16) Triality = ++half-Spinor Fermion Particles
= --half-Spinor Fermion AntiParticles
++half-Spinor Fermion Particles + --half-Spinor Fermion AntiParticles = 64+64 = 128 = E8 / D8

24 First Richa Syllables + 24 First Richa Gaps = D4sm + D4gde (purple box)

8x8 = 64 Last-8 Syllables of Last 8 lines = D8 / D4sm x D4gde (blue box)

8x8 = 64 (red box) plus 8x8 = 64 (green box) give 128 = E8 /D8 = Fermions
Middle-8 Syllables of Last 8 lines plus First-8 Syllables of Last 8 Lines

According to Wikipedia and emails from John Small:
"... **The Rig Veda is composed of ten books (called mandalas in Sanskrit) [that correspond to 10 Spacetime dimensions of 26D World-Line=String Theory]** ...

The first book [RV1] is a collection of hymns from seers of different families [encapsulating the whole Rig Veda] ...

Seven of the books [RV2 through RV8] each relate primarily to one great seer [and represent the 7 imaginary Octonions] ...
The ninth book is [RV9] Soma hymns [and represent the Octonion Real Axis]
Terence McKenna postulates that the most likely candidate for soma is the mushroom Psilocybe cubensis, a hallucinogenic mushroom that grows in cow dung ... the 9th mandala of the Rig Veda makes ... references to the cow as the embodiment of soma ...

The tenth book [RV10] [complements the first and fills in the gaps]...".

RV2 through RV9 together represent
the Octonion Structure of Spin(0,8) = Spin(1,7)
and the RP1 x S7 LIe Sphere Shilov Boundary of Type IV(8) Complex Domain
of Lie Ball Symmetric Space Spin(2,8) / Spin(8) x U(1)

RV1 and RV10 together represent
the (1,1) Conformal Structure of Spin(1,9) = Spin(2,8) = SL(2,O)

According to **The Constitution of the Universe by Maharishi Mahesh Yogi**, printed in The Wall Street Journal (6 January 1992) a copy of which was sent to me in pamphlet form by John Small in August 2003:
"... the ancient Vedic wisdom ... identifies a single, universal source of all orderliness in nature ... the Constitution of the Universe ... is embodied in the very structure of the sounds of the Rik Ved, the most fundamental aspect of the Vedic literature ...
According to Maharishi's Apaurusheya Bhashya, the structure of the Ved provides its own commentary ... The knowledge of the total Ved ... is contained in the first sukt of the Rik Ved ... The precise sequence of sounds is highly significant; it is in the sequential progression of sound and silence that the true meaning and content of the Ved reside ...
The complete knowledge of the Ved contained in the first sukt (stanza) is also found in the first richa (verse) - the first twenty-four syllables of the first sukt (stanza 1).
This complete knowledge is again contained in the first pad,
or first eight syllables of the first richa, and is also found in the first syllable of the Ved, 'AK', which contains the total dynamics of consciousness knowing itself.
According to Maharishi's Apaurusheya Bhashya of the Ved,
'AK' describes the collapse of the fullness of consciousness (A)
within itself to its own point value (K).
This collapse, which represents the eternal dynamics of consciousness knowing itself, occurs in eight successive stages.
In the next stage of unfoldment of the Ved, these eight stages of collapse
are separately elaborated in the eight syllables of the first pad,
which emerges from, and provides a further commentary on,
the first syllable of Rik Ved, 'AK'.
These eight syllables correspond to the eight 'Prakritis' (Ahamkar, etc.) or eight fundamental qualities of intelligence ...
The first line, or 'richa', of the first sukt, comprising 24 syllables, provides a further commentary on the first pad (phrase of eight syllables);
The first pad expresses the eight Prakritis ... with respect to the knower ... observer ... or 'Rishi' quality of pure consciousness.
The second pad expresses the eight Prakritis with respect to the process of knowing ... process of observation ... of 'Devata' (dynamism) quality of pure consciousness.
The third pad expresses the eight Prakritis with respect to the known ... observed ... or 'Chhandas' quality of pure consciousness. ...
The subsequent eight lines complete the remainder of the first sukt - the next stage of sequential unfoldment of knowledge in the Ved. These eight lines consist of 24 padas (phrases), comprising 8x24 = 192 syllables. ... these 24 padas of eight syllables elaborate the unmanifest, eight-fold structure of the 24 gaps between the syllables of the first richa (verse). ... Ultimately, in the subsequent stages of unfoldment, these 192 syllables of ther first sukt (stanza) get elaborated in the 192 suktas that comprise the first mandal (circular cyclical eternal structure) of the Rik Ved, which in turn gives rise to the rest of the Ved and the entire Vedic literature. ...".

According to Wikipedia:
“... Indra is praised as the highest god in 250 hymns of the Rigveda ...
the earliest reference to a net belonging to Indra is in the Atharva Veda ...
"Indra's net" is the net of the Vedic deva Indra,
whose net hangs over his palace on Mount Meru,
the axis mundi of Buddhist and Hindu cosmology.
In this metaphor, Indra's net has a multifaceted jewel at each vertex,
and each jewel is reflected in all of the other jewels.

...

Aspects of Indra as a deity are cognate to other ... thunder gods

...

Chango is the most feared god in Santería ... Ṣàngó is viewed as the most powerful ...
orisha ... He casts a "thunderstone" to earth, which creates **thunder** and lightning ...
Chango ... had three wives ... Princess Oshun, Princess Oba, and Princess Oya ...
Oshun is the deity of the river ... She is connected to destiny and **divination** ...
The abèbè is the ritual object most associated with Ọṣun. The abèbè is a fan in circular form ... with a **mirror** in the center ...”.

Chango and Indra both use Thunder,
and Chango’s wife Oshun does Divination with a Mirror
so
Chango and Oshun are two of the African IFA Orishas
who are precursors of Vedic Indra and Indra’s Net.

Japan, the next stop beyond Sunda of Human M174 migration Out of Africa,
has 128-element (Dixon Spinor part of IFA) Futomani Divination and similar culture:

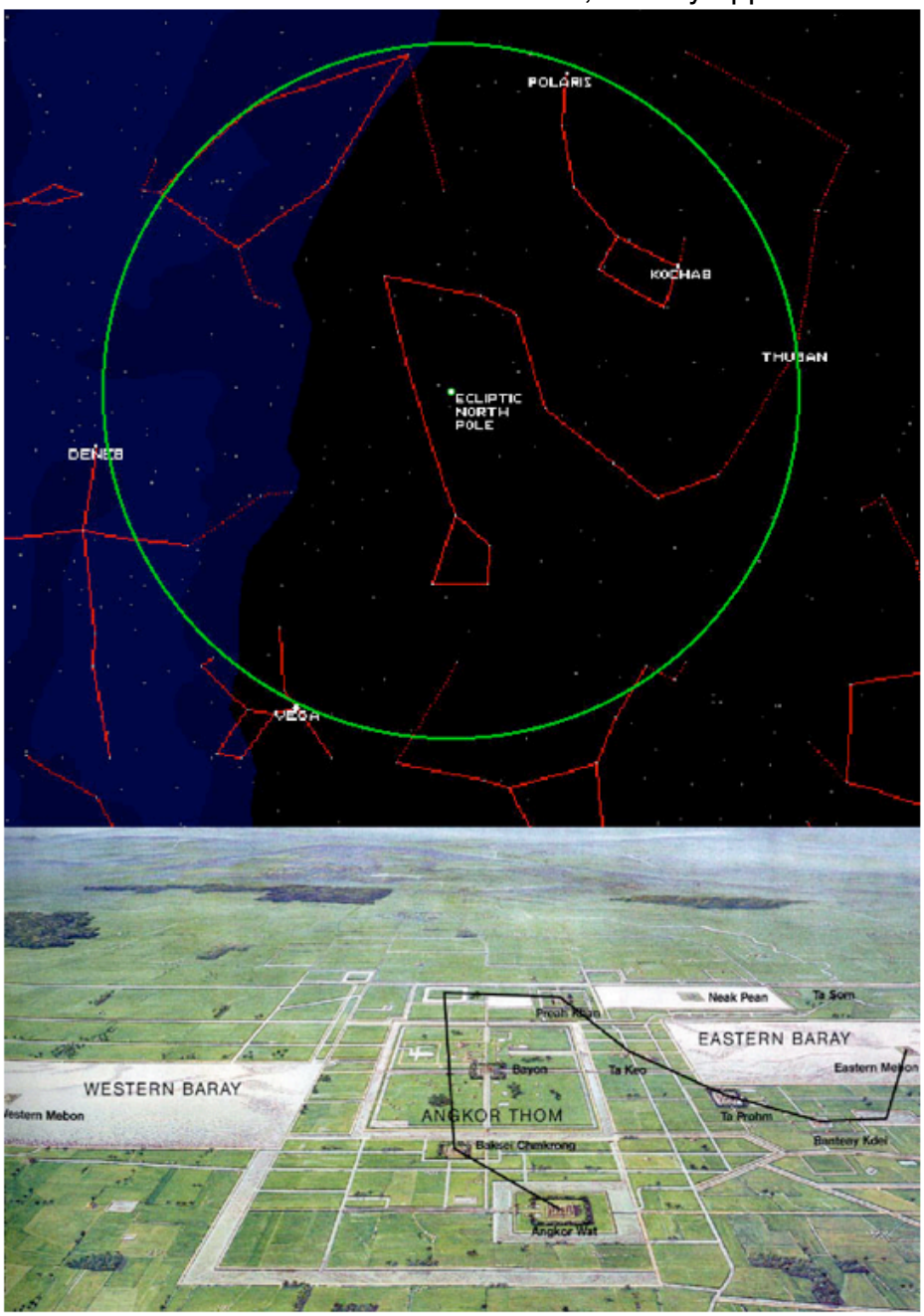


the sacred Yata no Kagami, or Eight-Handed Mirror - analogous to Indra Net Reflections

the Sword Kusanagi no Tsurugi - analogous to ThunderBolts

the curved Yasakani no Magatama Jewel - analogous to Indra Jewels

Graham Hancock, in Heaven's Mirror, said "... Our current world age is Pisces because on the spring equinox ... Pisces rises just ahead of the sun ... because of precession ... (1 degree in 72 years) ... the sun spends around 2160 years
[2160 = second layer vertices of all E8 Lie Algebra Lattices]
in each constellation - a complete revolution taking 26,000 years!
The great Hindu temple-complex ... spread over 200 square miles confirms that they correspond to the stars in the constellation of Draco, as they appeared in 10,500 BC! ...



...".

The same star configuration of 10,500 BC = 12,500 years ago would have appeared in the previous precession period about 38,500 years ago, with Vega as North Star and Angkor Thom as the Ecliptic North Pole, about the time humans first arrived from Africa.

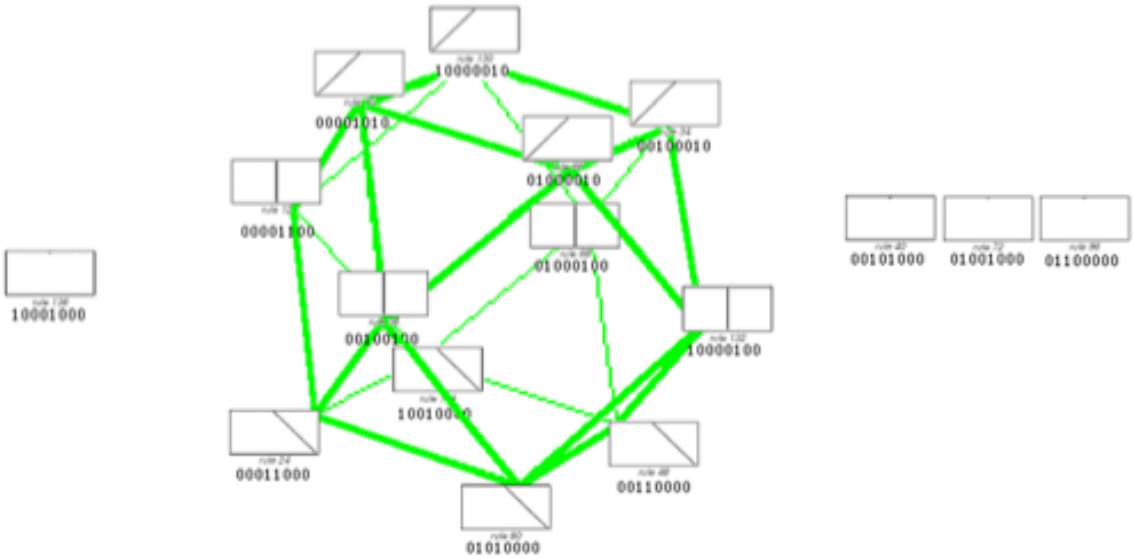
African Cellular Automata and Real Clifford Algebras

Ron Eglash (in his book "African Fractals" (Rutgers 1999) and on his web site) says: "...
a historical path for base-2 calculation ... begins with African divination,
runs through the geomancy of European alchemists,
and is finally transformed into binary calculation,
where it is now applied in every digital circuit ...".

Raymond Aschheim (email May 2015) said, about **Cellular Automata (CA)**:
"... An elementary CA is defined by the next value (either 0 or 1) for a cell,
depending on its ... value, and the ... value of it[s] left and of it[s] right neighbor cell
(it is one dimensional, and involve only the first neighbors, and the cell itself) ... So the
next value depends [on] 3 bits ... eight possible combination of three bits, and for
each ... combination... the next value is either zero or one.
So the[re] are **256 ... CAs** ...".

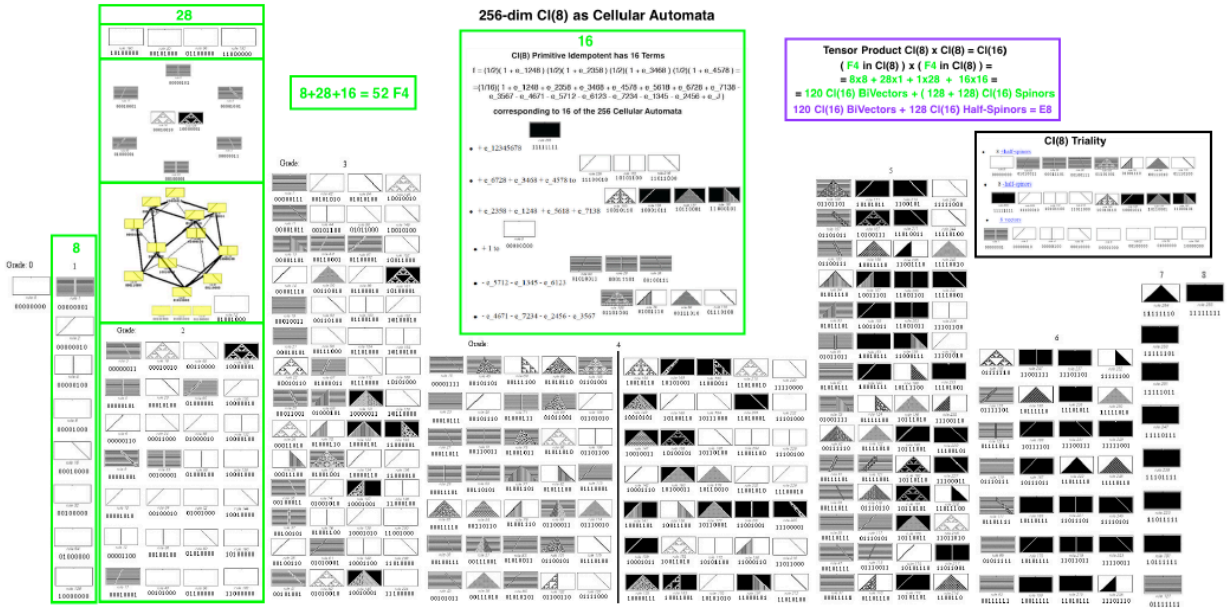
Since due to Real Clifford 8-periodicity any Real Clifford Algebra Cl(8N)) can
be seen as tthe tensor product of N copies of Cl(8), any Real Clifford Algebra has
fundamental structure of Cl(8) = Cl(1,7) = 16x16 real matrix algebra
so Cellular Automata correspondence with Cl(8) means
that any Real Clifford Algebra can be described by Cellular Automata
so **Clifford Algebra E8 physics can also be seen in terms of Cellular Automata**.

For example consider the 28 Cl(8) BiVector grade-2 Cellular Automata:
These 1 + 12 + 3 = 16 grade-2 Cellular Automata correspond to propagator phase,
Conformal Lie Algebra Root Vectors, and Conformal Lie Algebra Cartan Subalgebra



The Conformal Group Spin(2,4) = SU(2,2) gives Gravity+Dark Energy
by the MacDowell-Mansouri mechanism.
U(2,2) = U(1) x SU(2,2) also contains the propagator phase

These 1 + 3 + 8 = 12 grade-2 Cellular Automata correspond to
U(1) , SU(2) , SU(3) of the Standard Model



The 256 Elementary Cellular Automata correspond to the 256-dim Cl(8) Clifford Algebra with graded structure 1 8 28 56 (35+35=70) 56 28 8 1

The 8 Vectors have physical interpretation as 8-dim Spacetime.

The 28 BiVectors have two different physical interpretations:
as Gauge Bosons of Gravity+Dark Energy(16) and ghosts of Standard Model (12)
as Gauge Bosons of Standard Model (12) and ghosts of Gravity+Dark Energy(16)

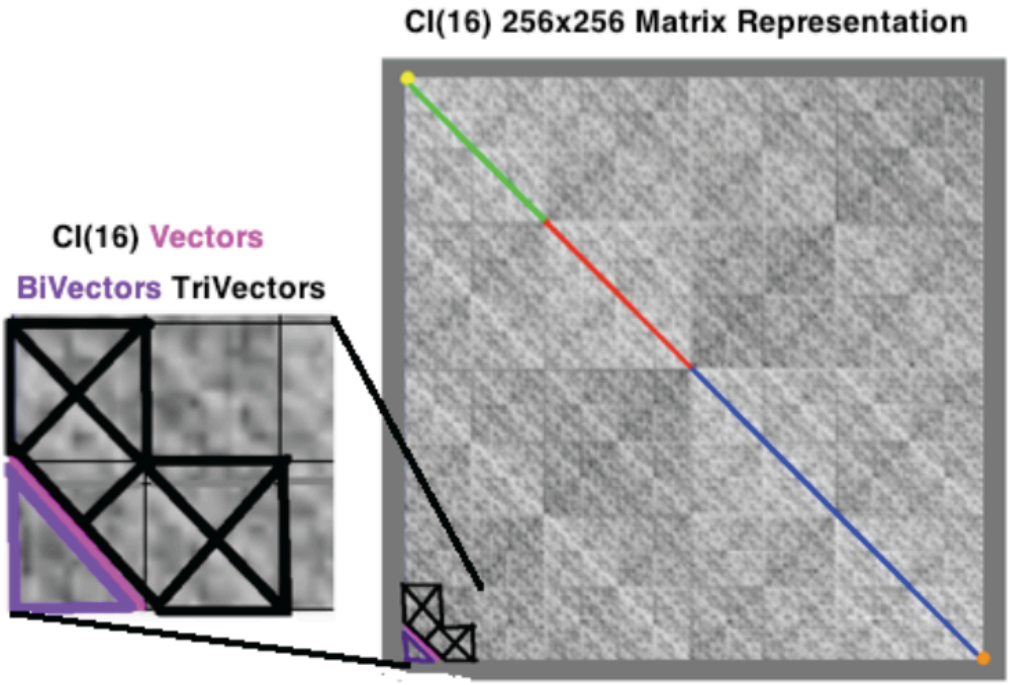
The 1 scalar, 1 pseudoscalar, and 7+7=14 of grade 4 have physical interpretation as 8 +half-spinors and 8 -half-spinors

The 8+28+8+8 = 52 with each physical interpretation form 52-dim F4.

The remaining 256 - 8 - 28 - 8 - 8 = 204 Cl(8) Cellular Automata are not bound to any physical interpretation but are available to carry information.

When Cl(16) is formed from the tensor product Cl(8) x Cl(8) the two F4 in Cl(8)
go to 1x28 + 8x8 + 28x1 = 120 D8 BiVectors and (8+8) x (8+8) = 256 D8 Spinors
all of which inherit clear physical interpretions
and
560 Cl(16) TriVectors = 10 copies of Fr3(O) = clear physical interpretation as
Complexification of 26D World-Line-String Theory over a 10D spacetime
with Tachyons producing Schwinger Sources
and spin-2 Bohmion Carriers of Bohm-Sutherland-Sarfatti Quantum Theory

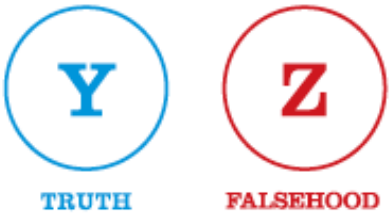
leaving 65,536 - 120 - 128 - 560 = 64,728 Cl(16) elements available to carry information in either
Lorentz Leech Lattice Spacetime Cells of Our Conscious Universe
or
40-micron Microtubules of Human Quantum Consciousness.



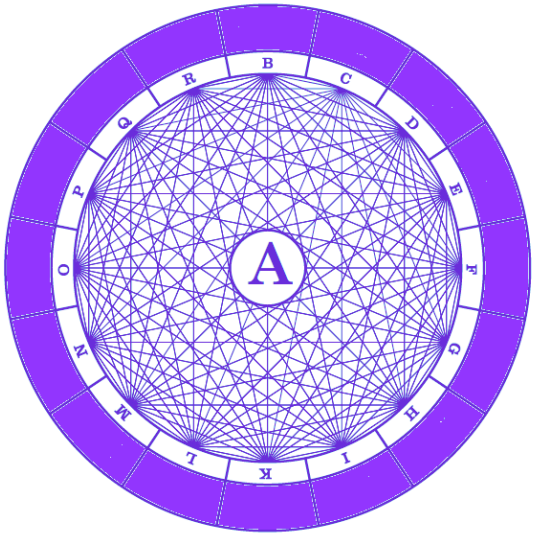
Africa and Ramon Llull and Cambridge Scholasticism

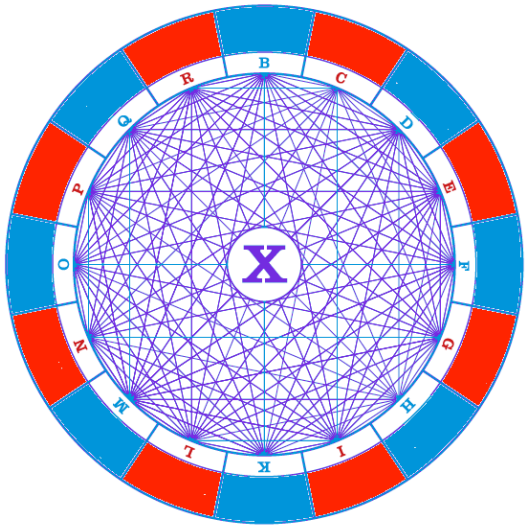
Ron Eglash (in his book "African Fractals" and on his web site) also says:
... **Following the introduction of geomancy to Europe by Hugo of Santalla in twelfth-century Spain ... European geomancers ... Ramon Lull** ... and others ... persistently replaced the deterministic aspects of the system with chance. **By mounting the 16 figures on a wheel and spinning it, they maintained their society's exclusion of any connections between determinism and unpredictability** ...".

Anthony Bonner in his book The Art and Logic of Ramon Llull (Brill 2007)
(unless otherwise stated illustrations herein are adapted from that book) said:
"... **Llull wanted to make the Art "general to everyone"** ...
"a religiously neutral universal science" ... for Llull the Art is not enclosed in its own shell, but ... can even be adapted to "many other principles of science" ...".
Ramon Llull's Y and Z Figures



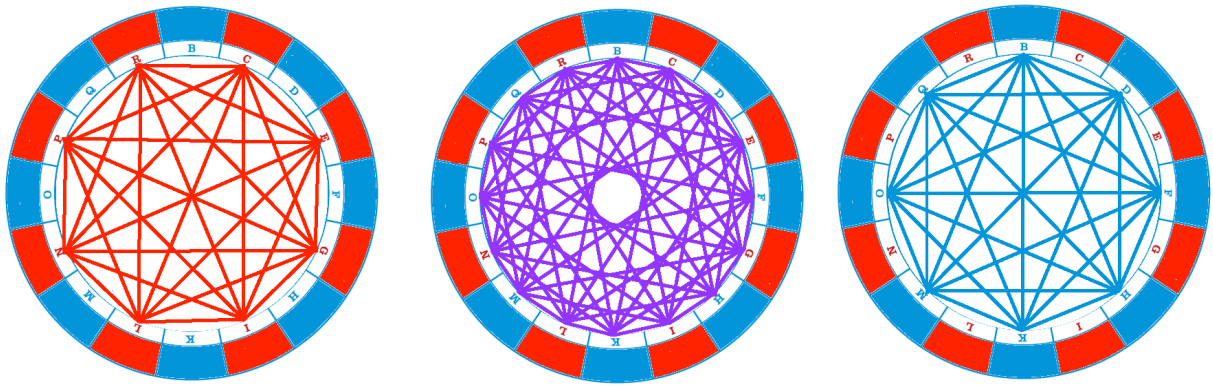
are analogous to the binary structure of IFA
Ramon Llull's Wheels A and X





have 16 vertices and 120 lines connecting pairs of vertices,
corresponding to the 16 vectors of the Real Clifford Algebra Cl(16)
and the 120 bivectors of Cl(16) that generate the 120-dim D8 Lie Algebra
in the 248-dim E8 Lie Algebra with E8 / D8 = 64 + 64 Fermion Particles + AntiParticles
representing 64 + 64 of E8 Maximal Contraction 28 + 64 + (A7+R) + 64 + 28

By 8-Periodicity of Real Clifford Algebras Cl(16) = tensor product Cl(8) x Cl(8)
so the 16 vectors of Cl(16) = 1 x 8 + 8 x 1 where 8 = 8 vectors of Cl(8)
and 8 of the 16 Wheel A vertices are the 8 blue vertices of Wheel X
and the other 8 Wheel A vertices are the 8 red vertices of Wheel X.



28 = 1 x 28 of the 120 D8 bivectors connect red vertices with red vertices
and represent the D4 Lie Algebra acting on the red 8-dim Cl(8) vector space
and 12 Standard Model Gauge Bosons plus 16 Gravity+Dark Energy Ghosts
representing 28 of E8 Maximal Contraction 28 + 64 + (A7+R) + 64 + 28

64 = 8 x 8 of the 120 D8 bivectors connect red vertices with blue vertices
and represent A7+R of E8 Maximal Contraction 28 + 64 + A7+R + 64 + 28

28 = 28 x 1 of the 120 D8 bivectors connect blue vertices with blue vertices
and represent the D4 Lie Algebra acting on the blue 8-dim Cl(8) vector space
and 16 Gravity+Dark Energy Gauge Bosons plus 12 Standard Model Ghosts
representing 28 of E8 Maximal Contraction 28 + 64 + (A7+R) + 64 + 28

Around 1300 Scholasticism was being developed
at the University of Paris, then the world's leading University, and
Cambridge and Oxford Universities which were getting organized based on Paris.

Doctor Illuminatus = Ramon Llull (1232-1315) produced a system of Logic
and a mathematical Art based on what is now known as the Clifford Algebra
Cl(16) and the 120 dimensional Lie algebra Spin(16). 700 years ago the details
of that mathematics were not known, nor was it known that the math structure of the Art
gives a realistic representation of E8 Physics of the Standard Model and Gravity+Dark
Energy along with its Algebraic Quantum Field Theory. (see viXra 1807.0166 and 1804.0121)
Doctor Subtilis = John Duns Scotus (1266-1308) developed Llull's system of Logic
into sophisticated Scholasticism, but did not have the math and physics knowledge
to show that the mathematical Art of Doctor Illuminatus gives a realistic physics model.
A Second Scholasticism began in 1540 with Ignatius Loyola under Pope Paul III

who founded the Jesuits, but, without the ability to experimentally measure
the relative strengths of the forces of the Standard Model and Gravity
and the relative masses of the elementary fermion particles
and to compare those observations with the physics model of Llull's mathematical Art,
by 1700 Scholasticism had been displaced by the Enlightenment of Descartes et al.

Now that we can do such experiments and make such observations
we can seeE8 Cl(16) Physics as a foundation for a Third Scholasticism.

Ron Eglash (in his book "African Fractals" and on his web site) also says:
"... European geomancers ... maintained their society's exclusion
of any connections between determinism and unpredictability ...
The Africans, on the other hand, seem to have emphasized such connections ...[with]...
a "trickster" god, one who is both deterministic and unpredictable. ...
The fractal settlement patterns of Africa stand in sharp contrast to the Cartesian grids of
Euro-American settlements. ... Euro-American cultures are ... "top-down" organization.
Precolonial African cultures included ... societies that are organized "bottom-up"
rather than "top-down". ... African architecture tends to be fractal because that is a
prominent design theme in African culture ... most of the indigenous African societies
were neither utterly anarchic, nor frozen in static order;
rather they utilized an adaptive flexibility ...
African traditions of decentralized decision making could ...
be combined with new information technologies,
creating new forms that
combine democratic rule with collective information sharing ...".

240 E8 Root Vectors = Lagrangian Physical Interpretation

Cl(16) BiVector + half-Spinor E8 structure of E8 gives
a Lagrangian for the Standard Model and Gravity + Dark Energy
with 8D Spacetime = M4 x CP2 Kaluza-Klein (where CP2 = SU(3) / SU(2)xU(1)).

E8 / D8 = 128 = 64 + 64 =
8 components of 8 First Generation Fermion Particles +
+ 8 components of 8 First Generation Fermion AntiParticles
= Spinor Fermion terms of the Lagrangian Density

D8 / D4 x D4 = 64 = 8x8 =
8-dim Spacetime for Lagrangian Base Manifold x 8 Fermion Types
Spacetime is a superposition of 8-dim spaces, one for each Fermion Type,
whose Quaternionic Structure is M4 x CP2 Kaluza-Klein (CP2=SU(3)/U(2))

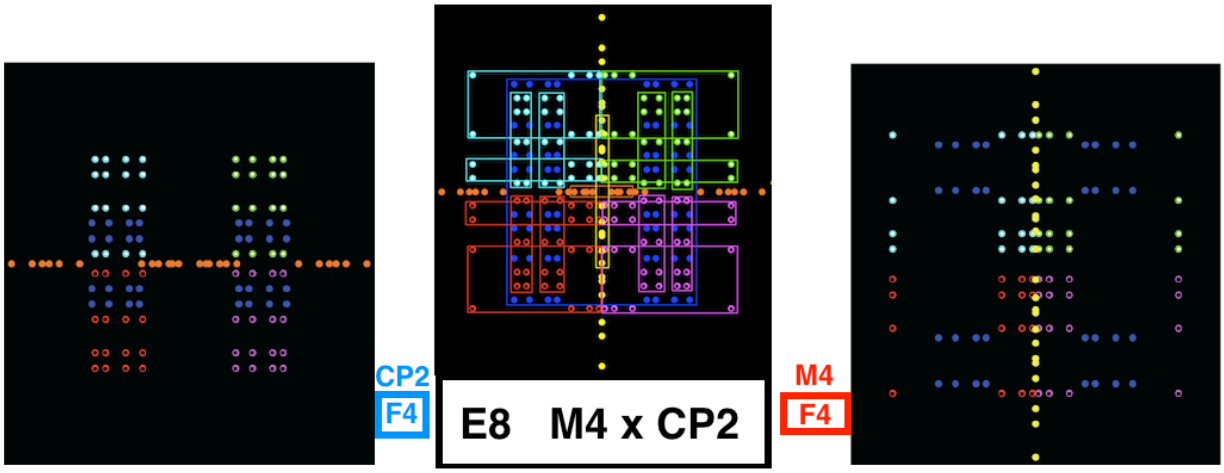
D4 = 28 = 16 + 12
where 16 = U(2,2) Conformal Group that gives Gravity + Dark Energy
as well as a U(1) propagator phase acting in M4 part of M4 x CP2
12 = M4 Ghosts of Standard Model Gauge Bosons

D4 = 28 = 12 + 16
where 12 = Standard Model Gauge Bosons acting in CP2 part of M4 x CP2
16 = CP2 Ghosts of Conformal U(2,2)

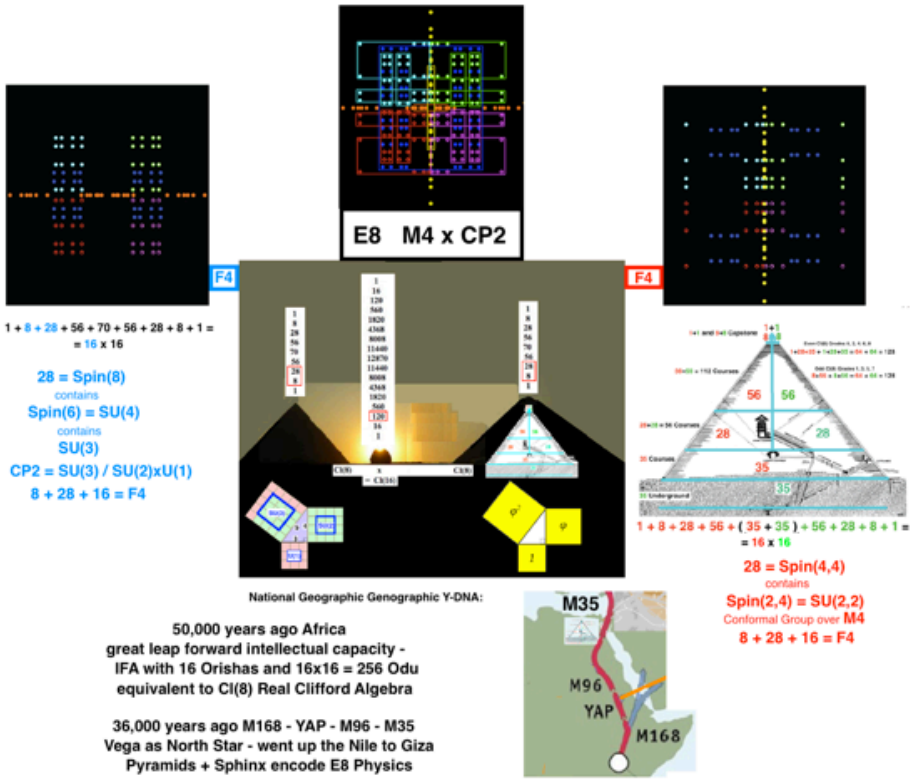
The 8D Lagrangian can be represented by the 240 Root Vectors of E8

Since the 48 Root Vectors of F4 = 24 vertices of 24-cell + 24 vertices of dual 24-cell
the 240 Root Vectors of E8 are made up of

120 Root Vectors of H4 for M4 = 24 F4 24-cell vertices + 96 F4 dual 24-cell edges
120 Root Vectors of H4 for CP2 = 24 F4 24-cell vertices + 96 F4 dual 24-cell edges



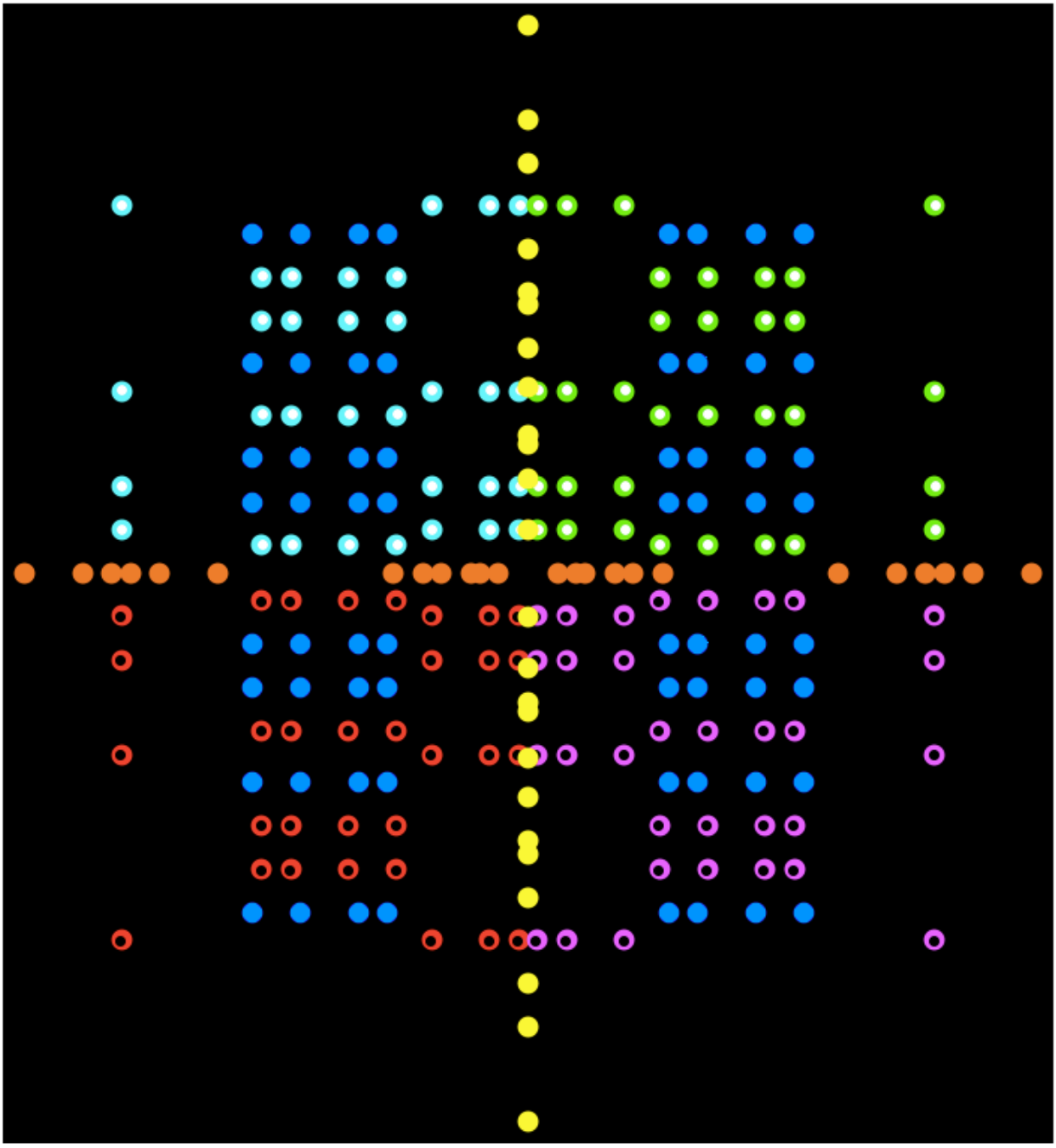
corresponding to the two large Pyramids and Sphinx of Giza



The following pages describe the physics of E8 Root Vectors and further physics details

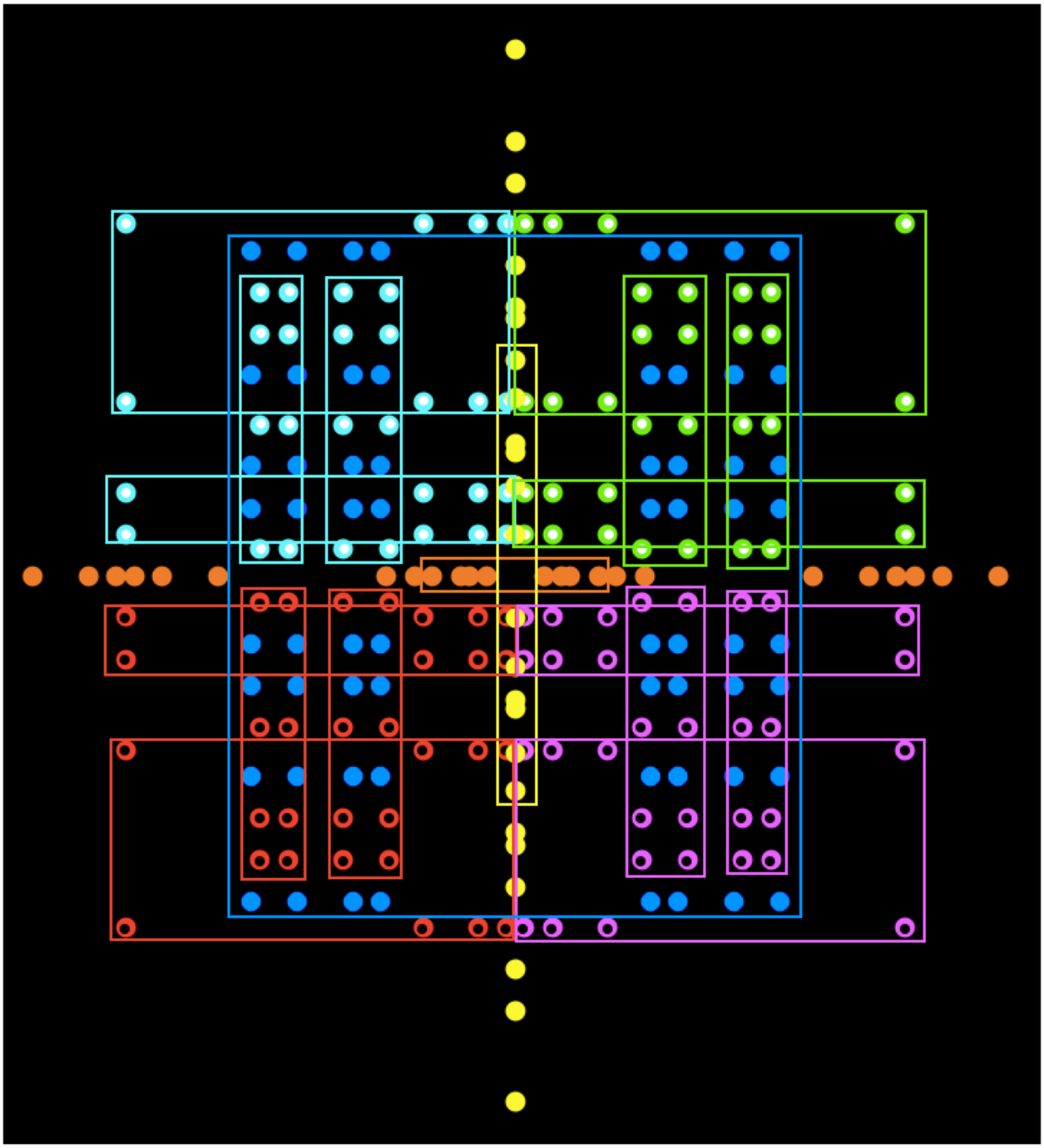
248-dim Lie Group E8 has 240 Root Vectors arranged on a 7-sphere S7 in 8-dim space.

Since it is hard to visualize points on S7 in 8-dim space,
I prefer to represent the 240 E8 Root Vectors in 2-dim / 3-dim space
as in this 2D representation by Ray Aschheim



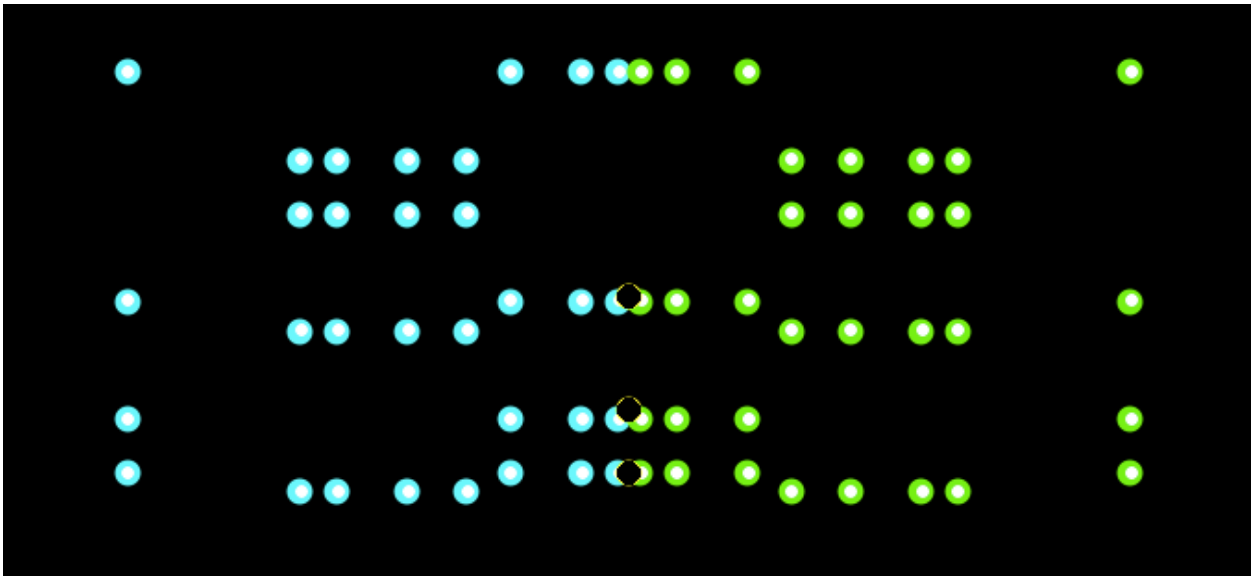
To understand the Geometry related to the 240 E8 Root Vectors, consider that

248-dim E8 = 120-dim Spin(16) D8 + 128-dim half-spinor of Spin(16) D8
240 E8 Root Vectors = **112 D8 Root Vectors** + **128 D8 half-spinors**
112 D8 Root Vectors = 24 D4 (orange) + 24 D4 (yellow) + 64 (blue)
128 D8 half-spinors = 128 elements of E8 / D8
Green and Cyan dots with white centers (32+32 = 64 dots) and
Red and Magenta dots with black centers (32+32 = 64 dots)
correspond to the 128 elements of E8 / D8.

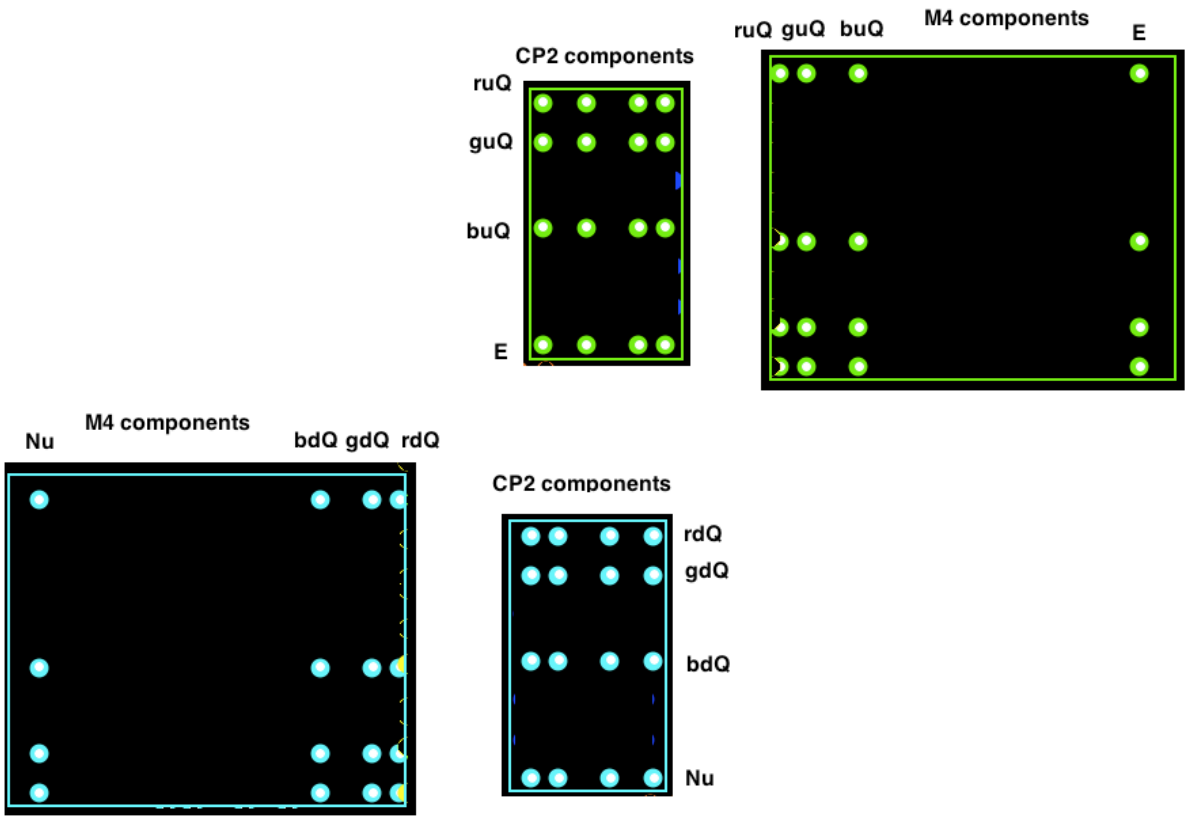


240 = 24 + 24 + 64 + 64 + 64

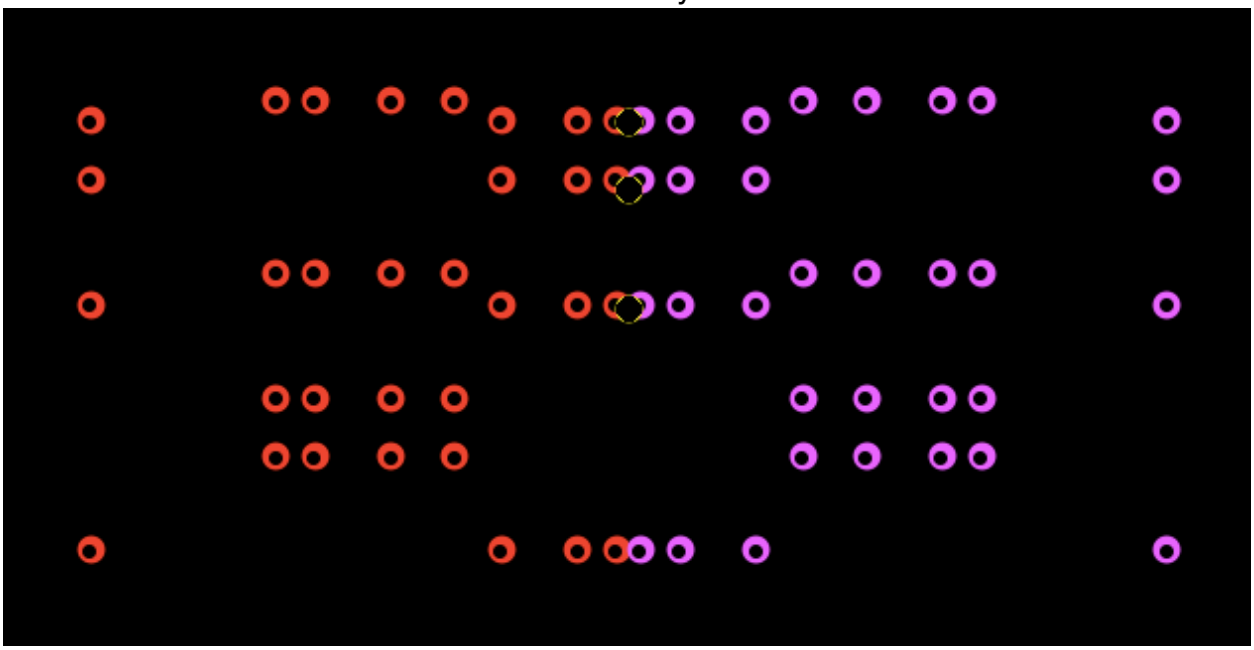
The 64 Green and Cyan Root Vectors represent half
of the First Generation Fermions of E8 / D8.
The White Centers of their dots indicate that they are Particles.



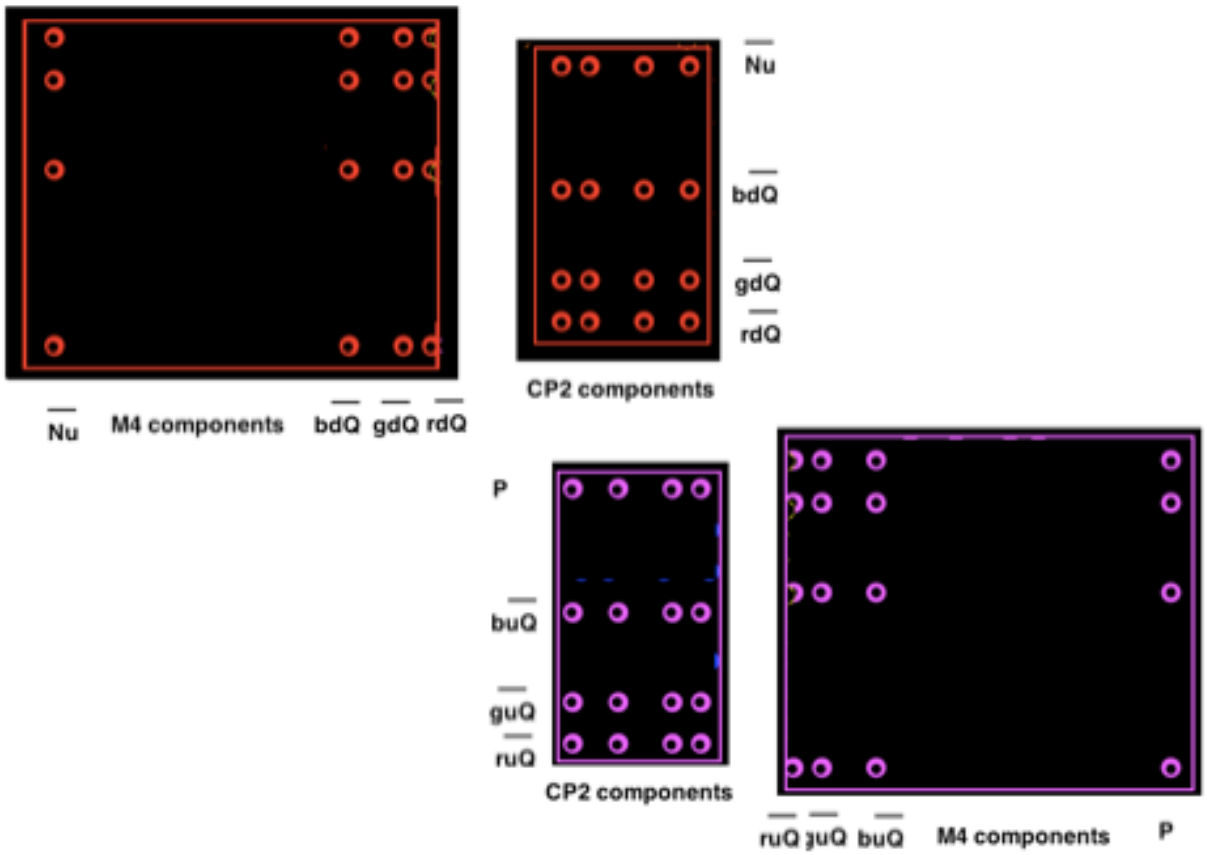
Their physical interpretatiions are



The 64 Red and Magenta Root Vectors represent the other half
of the First Generation Fermions of E8 / D8.
The Black Centers of their dots indicate that they are AntiParticles.



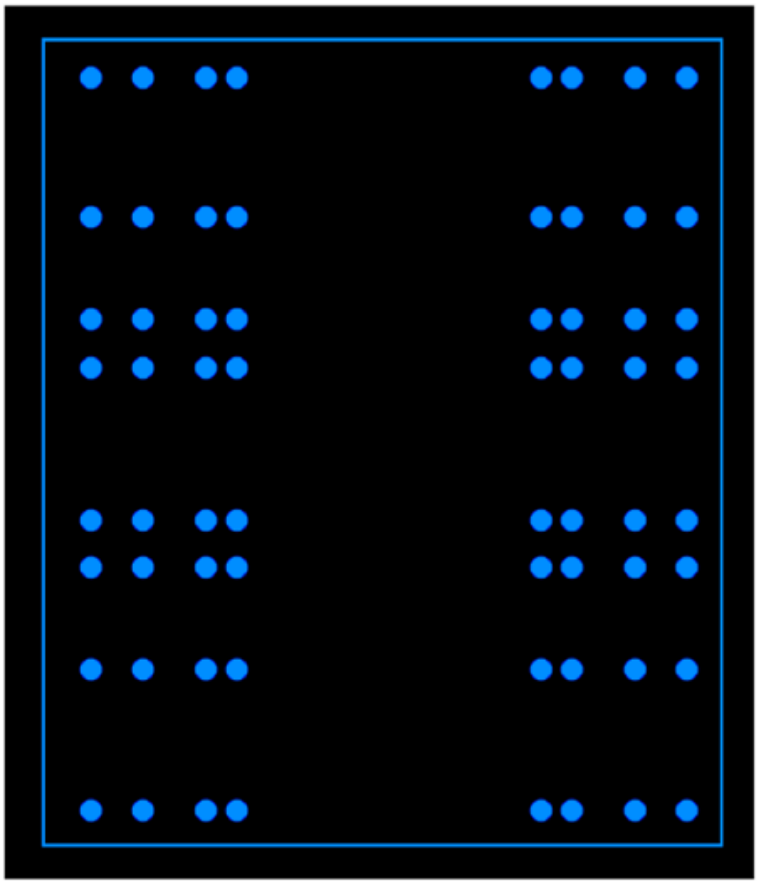
Their physical interpretations are



Spacetime, Unimodular Gravity, and Strong CP

The 64 Blue Root Vectors of the space D8 / D4 x D4 represent 8D Spacetime
and its symmetries such as 8 position x 8 momentum
and the A7 = SL(8,R) of Unimodular Gravity that is in the Maximal Contraction
Heisenberg Algebra of E8 with structure 28 + 64 + (A7+1) = 64 + 28.

(see Rutwig Campoamor-Stursberg in "Contractions of Exceptional Lie Algebras and SemiDirect Products" (Acta Physica Polonica B 41 (2010) 53-77)



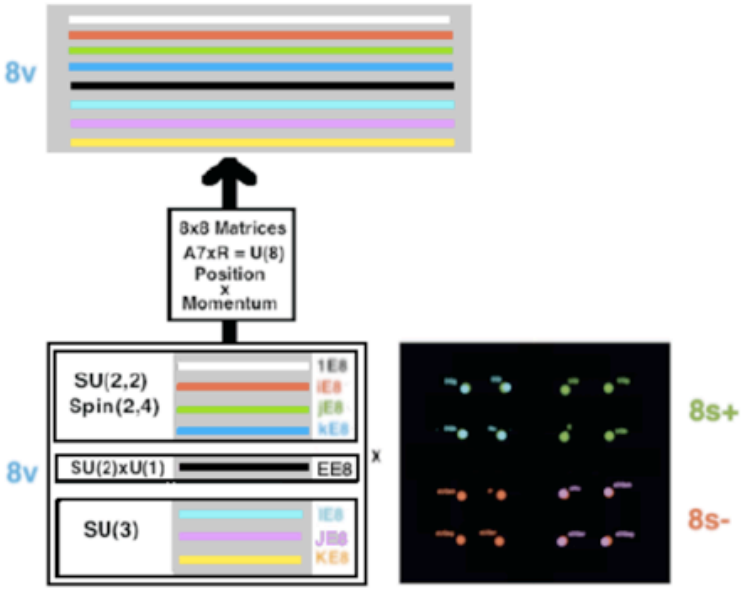
The 4x16 = 64 blue correspond to the
64-dim symmetric space D8 / D4 x D4 = Gr(8,16) Grassmannian = set of RP7 in RP15
They are related by Triality to the 64 + 64 Fermion Components of E8 / D8

Creation-Annihilation Operators for 8-dim spacetime x 8-dim momentum space are the 64-dim grade-0 part of the E8 Maximal Contraction generalized Heisenberg Algebra

h92 x A7 = 28 + 64 + **((SL(8,R)+1)** + 64 + 28

Bradonjic and Stachel in arXiv 1110.2159 said: "... in ... Unimodular relativity ... the metric tensor ... break[s up] ... into the conformal structure represented by a conformal metric ... with det = -1 and a four-volume element ... at each point of space-time ... [that]... may be the remnant, in the ... continuum limit, of a more fundamental discrete quantum structure of space-time itself ...".

In the Initial and Inflation Octonionic Phases of Our Universe
the 64 generators of D8 / D4 x D4 act as an Octonionic Conformal Structure
where Spin(0,8) of Cl(0,8) does rotations of 8-dim Octonion Space and
Spin(2,8) = Spin(1,9) = SL(2,O) of Cl(2,8) = Cl(1,9) = M(32,R) = M(2,Cl(0,8))
indicates a 10-dim Conformal Spacetime within 26-dim String Theory
and an 8-volume element at each point of Octonion Space indicates a fundamental
discrete structure of an underlying 26-dim String Theory in which
Strings = World-Lines and **a spin-2 particle carries Bohm Quantum Potential**.



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 ... massless particle ...
and ... **a ... massless ... spin two state** ...".

Unimodular SL(8,R) Gravity effectively describes a generalized checkerboard
of 8-dim SpaceTime HyperVolume Elements and, with respect to Cl(16) = Cl(8)xCl(8),
is the tensor product of the two 8v vector spaces of the two Cl(8) factors of Cl(16).
If those two Cl(8) factors are regarded as Fourier Duals,
then **8v x 8v describes Position x Momentum in 8-dim SpaceTime**.

In the Post-Inflation Quaternionic Phase of Our Universe
8-dim Octonionic Spacetime splits into (4+4)-dim **M4 x CP2 Kaluza-Klein Spacetime**
M4 underlies a 6-dim Conformal Spacetime of Spin(2,4) = SU(2,2)
where Spin(2,4) = BiVectors of Cl(2,4) = M(4,H) = 4x4 Quaternion Matrices
CP2 = SU(3) / SU(2) x U(1)
carries the Gauge Groups of the Standard Model

Frampton, Ng, and Van Dam in J. Math. Phys. 33 (1992) 3881-3882 said: "... Because of the existence of ... QCD ... instantons the quantized theory contains a dimensionless parameter ø ($0 < ø < 2\pi$) not explicit in the classical lagrangian. **... the quantum dynamics of ... unimodular gravity ... may lead to the relaxation of ø to ø = 0 (mod π) without the need ... for a new particle** ... such as the axion ...".

The 24 Orange Root Vectors of the D4 of **E8 Standard Model + Gravity Ghosts**
are on the Horizontal X-axis.
The 4 Cartan Subalgebra elements of D4 of E8 Standard Model + Gravity Ghosts
correspond to half of the 8 Cartan Subalgebra elements of E8.

In the Initial and Inflation Octonionic Phases of Our Universe
the 24+4 = 28 generators of D4 of E8 Standard Model + Gravity Ghosts
act as a Spin(8) Gauge Group rotating all 8 Fermion types into each other.

In the Post-Inflation Quaternionic Phase of Our Universe
8-dim Octonionic Spacetime splits into (4+4)-dim M4 x CP2 Kaluza-Klein Spacetime
8 generators 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.

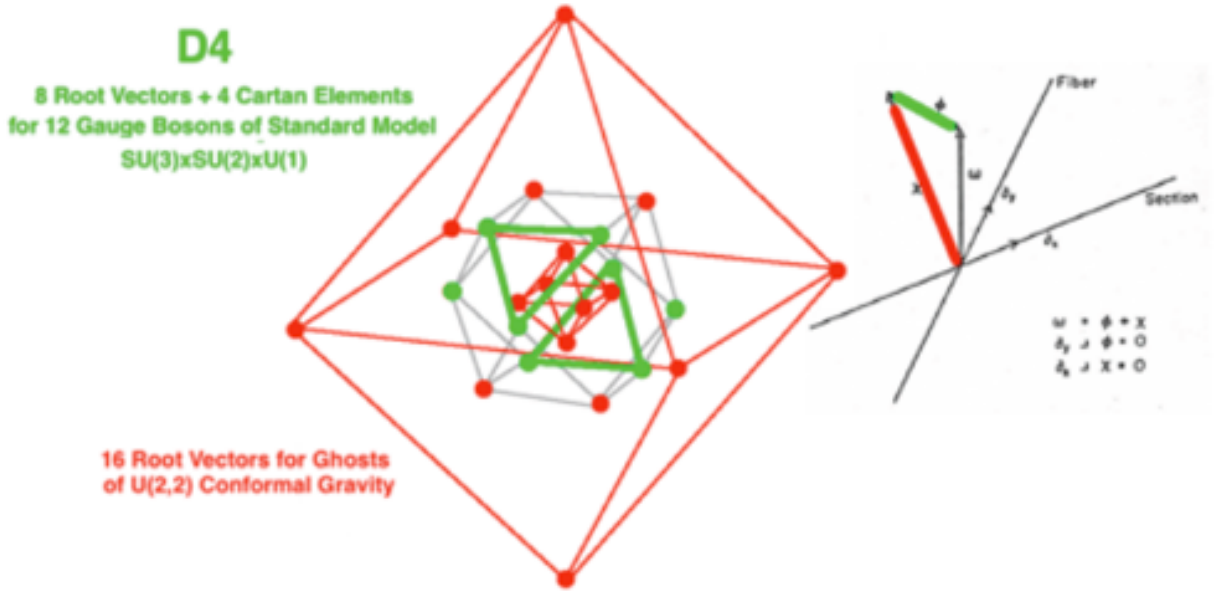
The other 24-8 = 16 Orange Root Vectors represent Ghosts of 16D U(2,2)
which contains the Conformal Group SU(2,2) = Spin(2,4)
that produces Gravity + Dark Energy by the MacDowell-Mansouri mechanism.

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

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

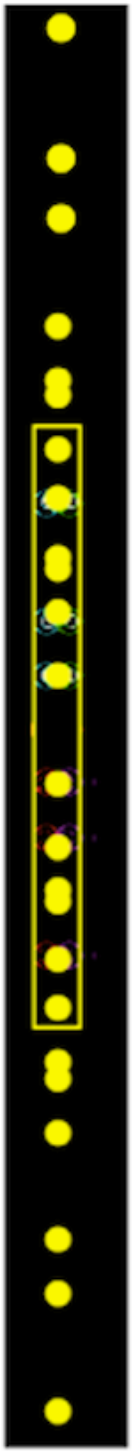
SU(3) is global symmetry group of CP2 but due to Kaluza-Klein M4 x CP2 structure of
compact CP2 at every M4 spacetime point,
it acts as Color gauge group with respect to M4.

The 24-8 = 16 D4 of CP2 Root Vectors represent Ghosts of U(2,2) Conformal Gravity.



Jean Thierry-Mieg in J. Math. Phys. 21 (1980) 2834-2838 said:
"... The ghost and the gauge field:
The single lines represent a local coordinate system
of a principal fiber bundle of base space-time.
The double lines are 1 forms.
The connection of the principle bundle w is assumed to be vertical.
Its contravariant components PHI and X are recognized, respectively,
as the Yang-Mills gauge field and the Faddeev-Popov ghost form ...".

Steven Weinberg in The Quantum Theory of Fields Volume II Section 15.7 said:
"... there is a beautiful geometric interpretation of the ghosts and the BRST symmetry ...
The gauge fields A_a^u may be written as one-forms A_a = A_a_u dx_u, where dx_μ
are a set of anticommuting c-numbers. ... This can be combined with the ghost to
compose a one-form *A*_a = A_a + w_a in an extended space.
Also, the ordinary exterior derivative d = dx^u d/dx^u may be combined with the BRST
operator s to form an exterior derivative D = d + s in this space,
which is nilpotent because s^2 = d^2 = sd + ds = 0 ...".

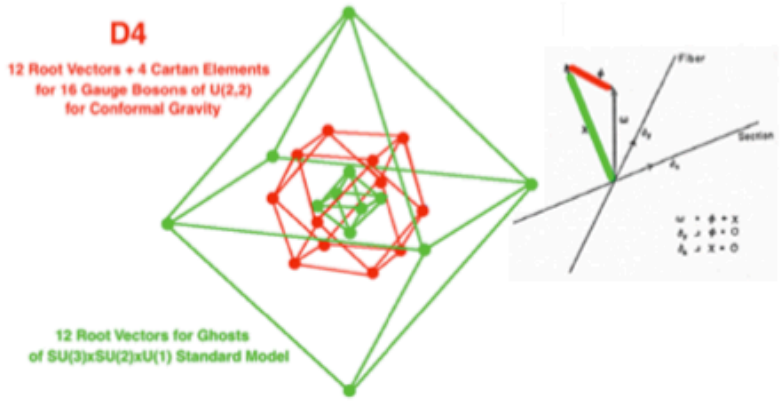


The 24 Yellow Root Vectors of the D4 of E8 Gravity + Standard Model Ghosts are on the Vertical Y-axis.
The 4 Cartan Subalgebra elements of D4 of E8 Gravity + Standard Model Ghosts correspond to half of the 8 Cartan Subalgebra elements of E8.

In the Initial and Inflation Octonionic Phases of Our Universe
the 24+4 = 28 generators of D4 of E8 Gravity + Standard Model Ghosts act as a Spin(8) Gauge Group rotating all 8 dimensions of Octonionic Spacetime into each other.

In the Post-Inflation Quaternionic Phase of Our Universe
8-dim Octonionic Spacetime splits into (4+4)-dim M4 x CP2 Kaluza-Klein Spacetime
12 generators 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)xU(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) SU(2) U(1)



Gravity and Dark Energy come from D4 Conformal Subgroup SU(2,2) = Spin(2,4)

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

1 Dilation representing Higgs Ordinary Matter

4 Translations representing Primordial Black Hole Dark Matter

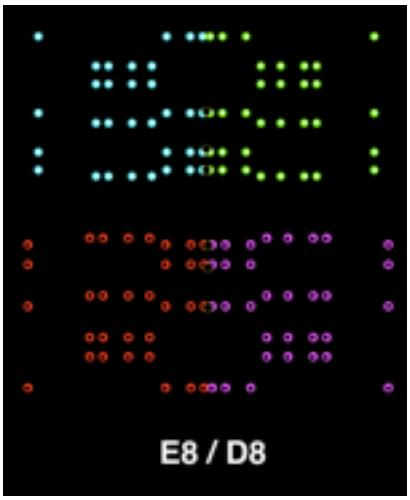
10 = 4 Special Conformal + 6 Lorentz representing Dark Energy
(see Irving Ezra Segal, "Mathematical Cosmology and Extragalactic Astronomy" (Academic 1976))

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 **0.75 : 0.21 : 0.04**

E8 Lagrangian

248-dim E8 = 120-dim D8 + 128-dim E8 / D8

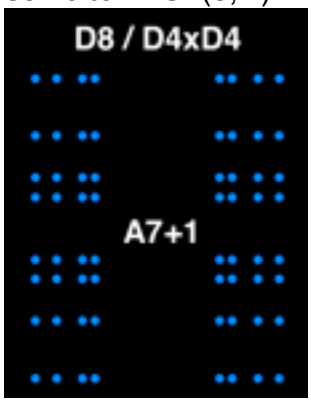
128-dim E8 / D8 = 64-dim 8 components of 8 First-Generation Fermion Particles
+
64-dim 8 components of 8 First-Generation Fermion AntiParticles



120-dim D8 = 28-dim D4sm + 28-dim D4gde + 64-dim (D8 / D4sm x D4gde)

28-dim D4sm = Spin(8) contains SU(4) contains Color Force SU(3) of Standard Model
28-dim D4gde = Spin(4,4) contains SU(2,2) = Spin(2,4) Conformal Group that gauges
by MacDowell-Mansouri to produce Einstein-Hilbert Gravity plus DE
DE = Dark Energy for Universe Expansion by I. E. Segal SU(2,2) Conformal Gravity

64-dim (D8 / D4sm x D4gde) Bosonic term SL(8,R)+1 = Unimodular Gravity in 8-dim



SL(8,R)+1 = A7+1 is the grade 0 part of the Heisenberg-type Algebra that is
the Maximal Contraction h92 x A7 (x = semidirect product) of E8 with graded structure

28 + 64 + (A7+1) + 64 + 28

which is the Creation / Annihilation algebra

grades -2 and 2 for D4sm and D4gde
grades -1 and 1 for E8 / D8 Fermion AntiParticle and Particle Components
grade 0 for 8-dim Octonionic Spacetime Position and Momentum

To build a Lagrangian for E8 Physics with E8 inside Cl(16) so that E8 = D8 + E8 / D8
start with a Lagrangian Density with these terms:

Fermion terms =
= 64-dim 8 components of 8 Particles + 64-dim 8 components of 8 AntiParticles

Gauge Boson and Ghost terms = D8 = D4sm + D4gde + (A7+1 = SL(8,R)+1)

To find the Base Manifold Spacetime over which to integrate the Lagrangian Density:
1 - The Fermion term components are consistent with 8-dim Base Manifold Spacetime
2 - The 64-dim Bosonic term SL(8,R)+1 describes Unimodular Gravity in 8-dim
So: the E8 Physics Lagrangian (at high energies) is

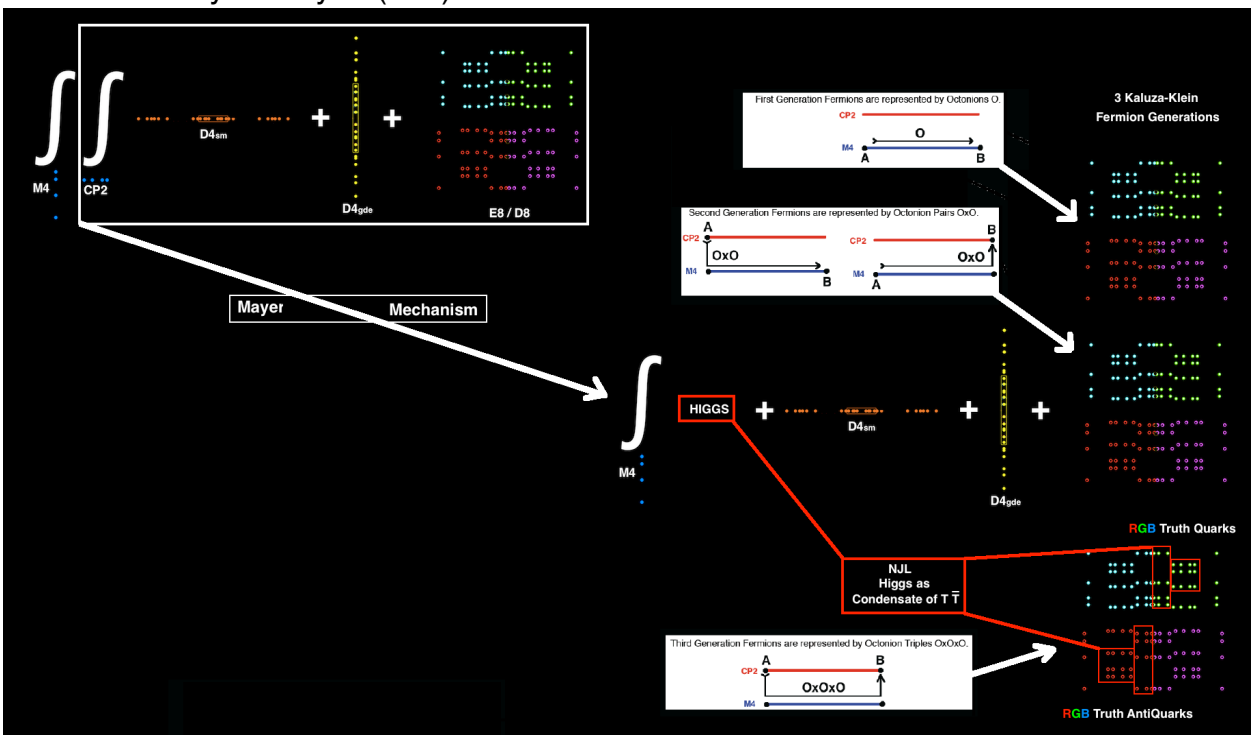
$$\int$$ D4sm + D4gde + SL(8,R)+1 + Fermion Terms

8D Octonionic Spacetime
There are two terms that act as Gravity:
SL(8,R)+1 Unimodular on 8D Octonionic Spacetime
and
D4gde Conformal SU(2,2) on 4D Quaternionic Spacetime

The Initial Octonionic Lagrangian, through Inflation, of E8 Physics is

End of Inflation and Quaternionic Structure

Octonionic symmetry of 8-dim spacetime is broken at the End of Octonionic Inflation to Quaternionic symmetry of (4+4)-dim Kaluza-Klein M4 x CP2



CP2 = SU(3) / SU(2)xU(1) gives Standard Model SU(3) x SU(2) x U(1)
(Batakis mechanism)

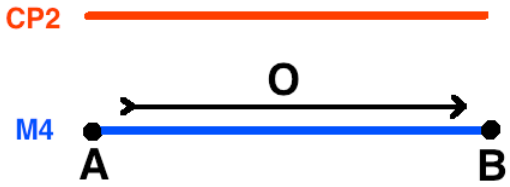
Decomposition to M4 x CP2 Kaluza-Klein gives Higgs
(Mayer-Trautman mechanism)

and

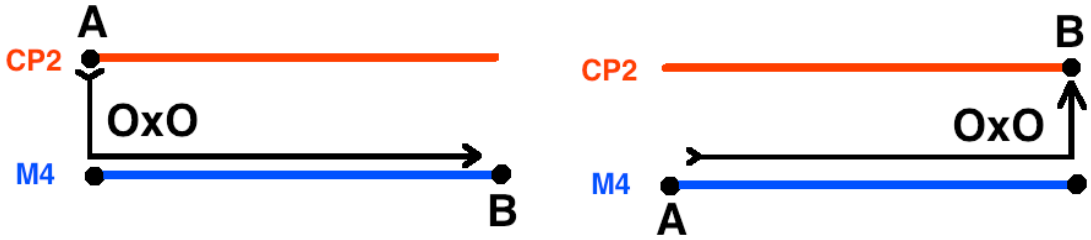
gives 2nd and 3rd generations of Fermions

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:

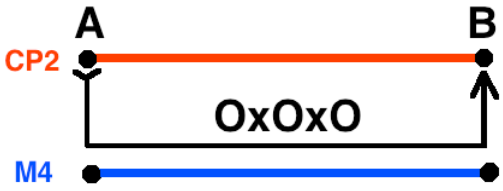
1 - A and B are both in M4: First Generation Fermion
whose path can be represented by the single O basis element
so that First Generation Fermions are represented by Octonions O.



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



The 8D-4D E8 Lagrangian System has these characterictics:

Lagrangian has 8-dim Lorentz structure satisfying Coleman-Mandula because its Fermionic fundamental spinor representations are built with respect to spinor representations for 8-dim Spin(1,7) spacetime - see Steven Weinberg, "The Quantum Theory of Fields" Volume III

Lagrangian is UltraViolet finite because each Fermionic Term Fermion has in 8-dim Spacetime units of mass^(7/2) and each Bosonic Gauge Boson + Ghost Term has units of mass^(1), so, since (8+8)x(7/2) = 56 = 28 + 28 the Fermionic Terms cancel the Bosonic Terms - see Steven Weinberg "1986 Dirac Lectures Elementary Particles and the Laws of Physics"

Lagrangian is Chiral because E8 contains Cl(16) half-spinors (64+64) for a Fermion Generation but does not contain Cl(16) Mirror Fermion AntiGeneration half-spinors. Fermion +half-spinor Particles with high enough velocity are seen as left-handed. Fermion -half-spinor AntiParticles with high enough velocity are seen as right-handed.

Lagrangian obeys Spin-Statistics because the CP2 part of M4xCP2 Kaluza-Klein has index structure Euler number 2+1 = 3 and Atiyah-Singer index -1/8 which is not the net number of generations because CP2 has no spin structure but you can use a generalized spin structure (Hawking and Pope (Phys. Lett. 73B (1978) 42-44)) to get (for integral m) the generalized CP2 index n_R - n_L = (1/2) m (m+1) Prior to Dimensional Reduction: m = 1, n_R - n_L = (1/2)x1x2 = 1 for 1 generation After Reduction to 4+4 Kaluza-Klein: m = 2, n_R - n_L = (1/2)x2x3 = 1 for 3 generations Hawking and Pope say: "Generalized Spin Structures in Quantum Gravity ...what happens in CP2 … one could replace the electromagnetic field by a Yang-Mills field whose group G had a double covering G~. The fermion field would have to occur in representations which changed sign under the non-trivial element of the kernel of the projection … G~ -> G while the bosons would have to occur in representations which did not change sign …". For E8 physicsl gauge bosons are in the 28+28=56-dim D4xD4 subalgebra. D4 = SO(8) is the Hawking-Pope G with double covering G~ = Spin(8). The 8 fermion particles / antiparticles are D4 half-spinors represented within E8 by anti-commutators and so do change sign while the 28 gauge bosons are D4 adjoint represented within E8 by commutators and so do not change sign.

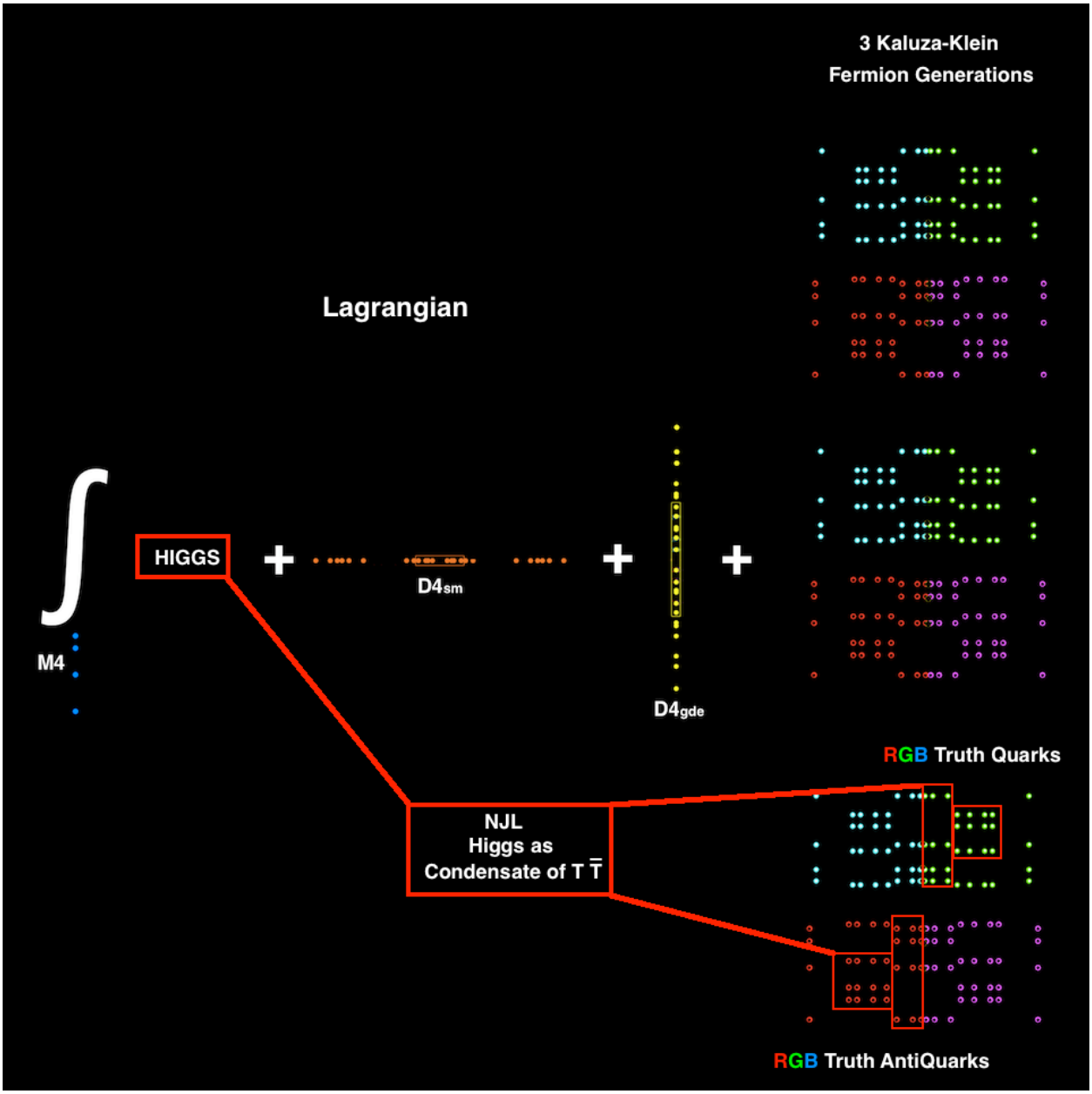
E8 Lagrangian inherits from F4 the property whereby its Spinor Part need not be written as Commutators but can also be written in terms of Fermionic AntiCommutators - see Pierre Ramond hep-th/0112261 -also, F4 lives in Cl(8) as Vectors + BiVectors + Spinors and by 8-Periodicity Cl(16) = tensor product Cl(8) x Cl(8) and E8 lives in Cl(16) as BiVectors + half-Spinors.

E8 Physics Calculation Results

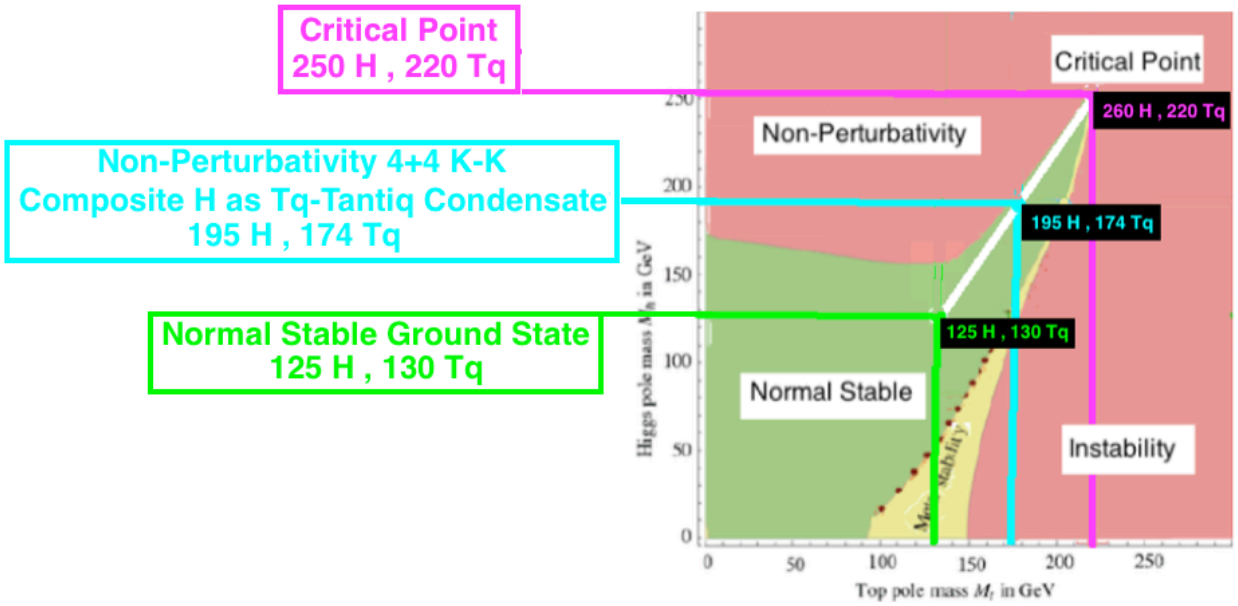
Here is a summary of E8 Physics model calculation results. Since ratios are calculated, values for one particle mass and one force strength are assumed. Quark masses are constituent masses. Most of the calculations are tree-level, so more detailed calculations might be even closer to observations.

```
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.

Particle/Force           Tree-Level        Higher-Order
e-neutrino                  0                0 for nu_1
mu-neutrino                 0           9 x 10^(-3) eV for nu_2
tau-neutrino                0          5.4 x 10^(-2) eV for nu_3

electron                0.5110 MeV
down quark               312.8 MeV      charged pion = 139 MeV
up quark                 312.8 MeV       proton = 938.25 MeV
                                       neutron - proton = 1.1 MeV
muon                     104.8 MeV            106.2 MeV
strange quark              625 MeV
charm quark               2090 MeV

tauon                     1.88 GeV
beauty quark              5.63 GeV
truth quark (low state)    130 GeV      (middle state) 174 GeV
                                          (high state) 218 GeV

W+                      80.326 GeV
W-                      80.326 GeV
W0                      98.379 GeV           Z0 = 91.862 GeV

Mplanck            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)(Mproton^2 / Mplanck^2)                    5 x 10^(-39)
EM fine structure        1/137.03608
Weak Gw                    0.2535
Gw(Mproton^2 / (Mw+^2 + Mw-^2 + Mz0^2))      1.05 x 10^(-5)
Color Force at 0.245 GeV   0.6286            0.106 at 91 GeV

Kobayashi-Maskawa parameters for W+ and W- processes are:
      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
The phase angle d13 is taken to be 1 radian.
```

Nambu - Jona-Lasinio Truth Quark-AntiQuark Condensate Higgs



forms a Higgs-Tquark NJL-type system with 3 Mass States



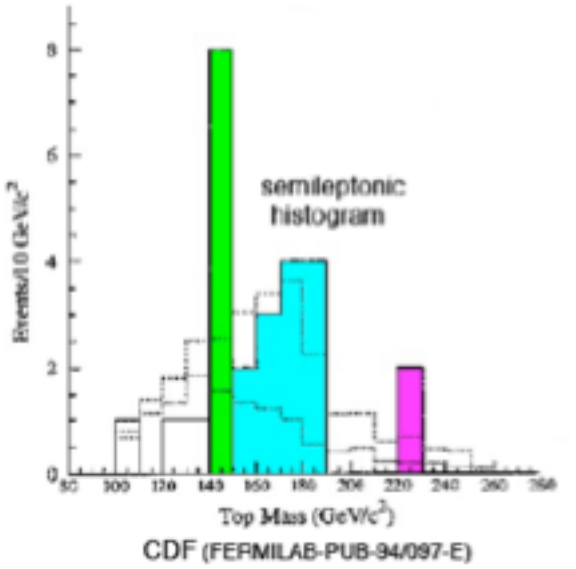
The Green Dot  where the White Line originates in our Ordinary Phase is the **Low-mass state of a 130 GeV Truth Quark and a 125 GeV Higgs.**

The 130 GeV Tquark mass is also predicted by Connes's NCG (NonCommutative Geometry) by the formula Mt = sqrt(8/3) Mw

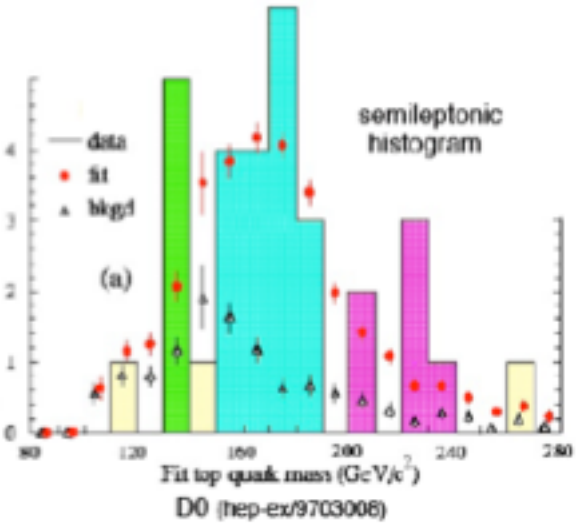
The Cyan Dot  where the White Line hits the Triviality Boundary leaving the Ordinary Phase is the **Middle-mass state of a 174 GeV Truth Quark and Higgs around 200 GeV**. It corresponds to the Higgs mass calculated by Hashimoto, Tanabashi, and Yamawaki in hep-ph/0311165 where they say:
"... We perform the most attractive channel (MAC) analysis in the top mode standard model with TeV-scale extra dimensions, where the standard model gauge bosons and the third generation of quarks and leptons are put in D(=6,8,10,...) dimensions. In such a model, bulk gauge couplings rapidly grow in the ultraviolet region. In order to make the scenario viable, only the attractive force of the top condensate should exceed the critical coupling, while other channels such as the bottom and tau condensates should not. We then find that the top condensate can be the MAC for D=8 ... We predict masses of the top (m_t) and the Higgs (m_H) ... based on the renormalization group for the top Yukawa and Higgs quartic couplings with the compositeness conditions at the scale where the bulk top condenses ... for ...[Kaluza-Klein type]... dimension... D=8 ...
m_t = 172-175 GeV and m_H=176-188 GeV ...".
As to composite Higgs and the Triviality boundary, Pierre Ramond says in his book Journeys Beyond the Standard Model (Perseus Books 1999) at pages 175-176: "... The Higgs quartic coupling has a complicated scale dependence. It evolves according to d lambda / d t = (1 / 16 pi^2) beta_lambda where the one loop contribution is given by beta_lambda = 12 lambda^2 - ... - 4 H ... The value of lambda at low energies is related [to] the physical value of the Higgs mass according to the tree level formula m_H = v sqrt(2 lambda) while the vacuum value is determined by the Fermi constant ... for a fixed vacuum value v, let us assume that the Higgs mass and therefore lambda is large. In that case, beta_lambda is dominated by the lambda^2 term, which drives the coupling towards its Landau pole at higher energies.
Hence the higher the Higgs mass, the higher lambda is and the close[r] the Landau pole to experimentally accessible regions.
This means that for a given (large) Higgs mass, we expect the standard model to enter a strong coupling regime at relatively low energies, losing in the process our ability to calculate. This does not necessarily mean that the theory is incomplete, only that we can no longer handle it ... it is natural to think that this effect is caused by new strong interactions, and that the Higgs actually is a composite ...
The resulting bound on lambda is sometimes called the triviality bound.
The reason for this unfortunate name (the theory is anything but trivial) stems from lattice studies where the coupling is assumed to be finite everywhere; in that case the coupling is driven to zero, yielding in fact a trivial theory.
In the standard model lambda is certainly not zero. ...".

The Magenta Dot  at the end of the White Line is the **High-mass state of a 220 GeV Truth Quark and a 240 GeV Higgs**. It is at the critical point of the Higgs-Tquark System with respect to Vacuum Instability and Triviality. It corresponds to the description in hep-ph/9603293 by Koichi Yamawaki of the Bardeen-Hill-Lindner model: "... the BHL formulation of the top quark condensate ... is based on the RG equation combined with the compositeness condition ... start[s] with the SM Lagrangian which includes explicit Higgs field at the Lagrangian level ...
BHL is crucially based on the perturbative picture ...[which]... breaks down at high energy near the compositeness scale /\ ...[10^19 GeV]...
there must be a certain matching scale /_Matching such that
the perturbative picture (BHL) is valid for mu < /_Matching, while only the nonperturbative picture (MTY) becomes consistent for mu > /_Matching ...
However, thanks to the presence of a quasi-infrared fixed point,
BHL prediction is numerically quite stable against ambiguity at high energy region, namely, rather independent of whether this high energy region is replaced by MTY or something else. ... Then we expect mt = mt(BHL) = ... = 1/(sqrt(2)) ybart v within 1-2%, where ybart is the quasi-infrared fixed point given by Beta(ybart) = 0 in ... the one-loop RG equation ...
The composite Higgs loop changes ybart^2 by roughly the factor Nc/(Nc +3/2) = 2/3 compared with the MTY value, i.e., 250 GeV -> 250 x sqrt(2/3) = 204 GeV, while the electroweak gauge boson loop with opposite sign pulls it back a little bit to a higher value. The BHL value is then given by mt = 218 +/- 3 GeV, at /\ = 10^19 GeV.
The Higgs boson was predicted as a tbar-t bound state
with a mass MH = 2mt based on the pure NJL model calculation.
Its mass was also calculated by BHL through the full RG equation ...
the result being ... MH / mt = 1.1) at /.\ = 10^19 GeV ...
... the top quark condensate proposed by Miransky, Tanabashi and Yamawaki (MTY) and by Nambu independently ... entirely replaces the standard Higgs doublet by a composite one formed by a strongly coupled short range dynamics (four-fermion interaction) which triggers the top quark condensate.
The Higgs boson emerges as a tbar-t bound state and hence is deeply connected with the top quark itself. ... MTY introduced explicit four-fermion interactions responsible for the top quark condensate in addition to the standard gauge couplings. Based on the explicit solution of the ladder SD equation, MTY found that even if all the dimensionless four-fermion couplings are of O(1), only the coupling larger than the critical coupling yields non-zero (large) mass ... The model was further formulated in an elegant fashion by Bardeen, Hill and Lindner (BHL) in the SM language, based on the RG equation and the compositenes condition. BHL essentially incorporates 1/Nc sub-leading effects such as those of the composite Higgs loops and ... gauge boson loops which were disregarded by the MTY formulation. We can explicitly see that BHL is in fact equivalent to MTY at 1/Nc-leading order. Such effects turned out to reduce the above MTY value 250 GeV down to 220 GeV ...".

Fermilab has seen all 3 Truth Quark Mass States:



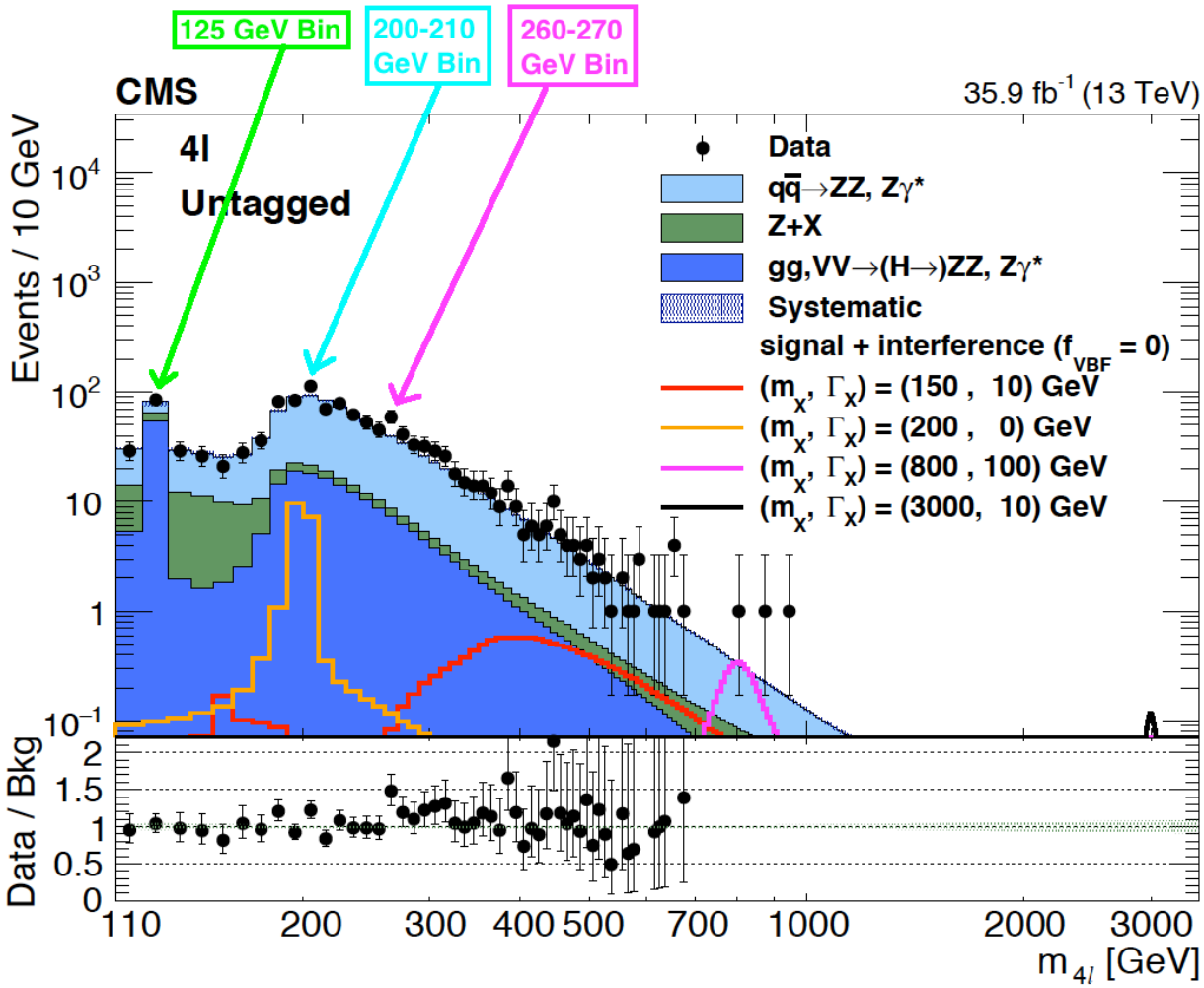
CDF (FERMILAB-PUB-94/097-E)



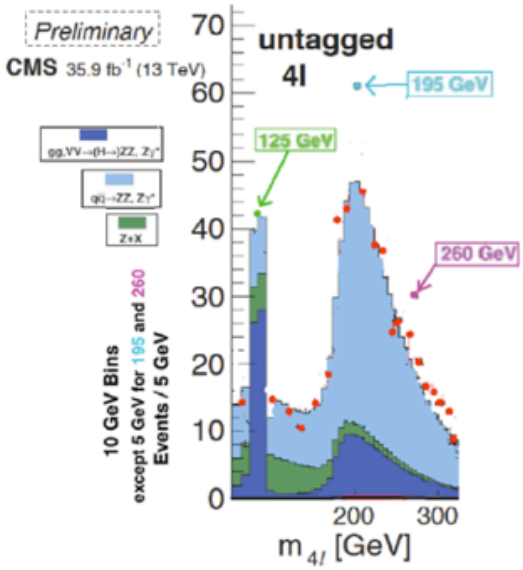
D0 (hep-ex/9703006)

At the LHC, CMS has seen all 3 Higgs Mass States:

CMS at arXiv 1804.01939 released a histogram in the Higgs -> ZZ* -> 4l channel for the 35.9 fb-1 of 2015-2016 LHC Run2 data that shows all 3 Higgs Mass States



The log scale for event number used by CMS makes the Higgs peaks look small.
The peaks appear more realistic using a linear scale for event number:



Cl(16) TriVector Fr3(O) World-Line String Bohm Quantum Theory Tachyons

Cl(16) TriVector Fr3(O) with J3(O)o structure gives a 26D String Theory with World-Lines = Strings and Tachyons to produce Schwinger Sources and traceless spin-2 symmetric Bohm Quantum Potential

The 560 TriVectors of Cl(16) with Jordan Product
form 10 copies of the 56-dim Fr3(O) Freudenthal Algebra
each of which contains two copies of the 27-dim J3(O) Jordan Algebra
of 3x3 Hermitian Octonion matrices and therefore contains the
complexification of 26-dim String Theory described by traceless J3(O)o

The complexification is necessary for representation of Fermions and
Spacetime as E6 / D5 and D5 / D4 (instead of F4 / B4 and B4 / D4) thus giving
Complex Bounded Domains and their Shilov Boundaries whose volumes
are used in calculations of Force Strengths, Particle Masses, etc.

To see this, start with the 56 TriVectors of Cl(8) with Jordan Product
that form the Freudenthal Algebra Fr3(O)

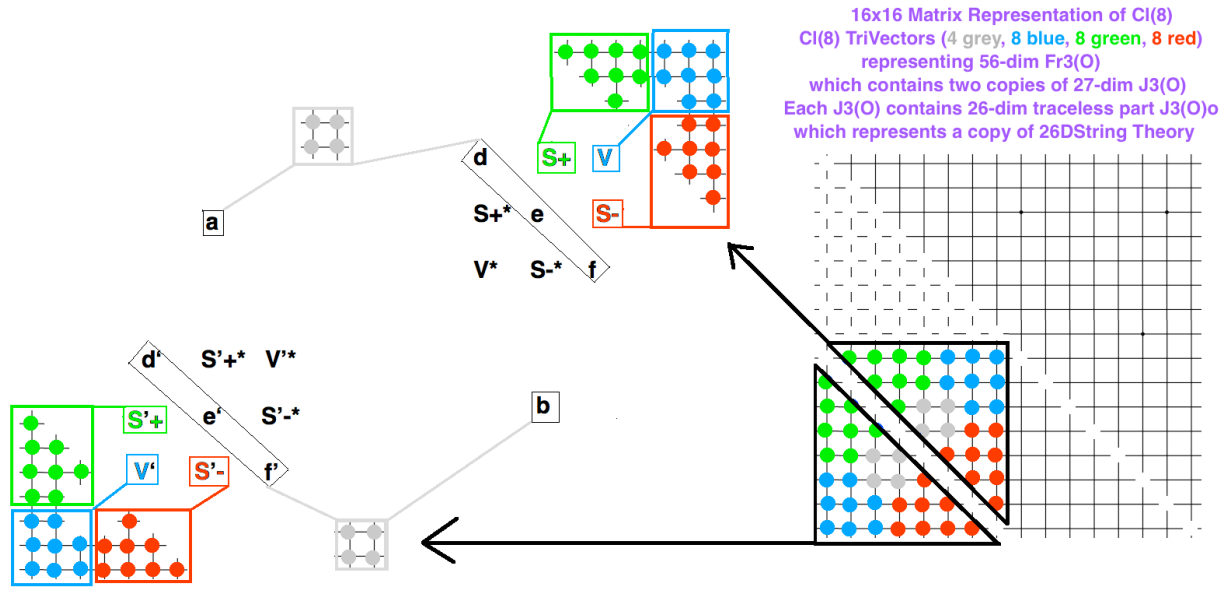
Fr3(O) is Zorn-type matrices
where
a,b,d,d',e,e',f,f' are Real Numbers
and
S+,S'+,V, V',S-,S'- are Octonions
and
*** = Conjugate**

a	d	S+ V
	S+*	e S-
	V*	S-* f

d‘	S’+*	V’*
S’+	e‘	S’-*
V‘	S’-	f’

b

and use the 16x16 Matrix Representation of Cl(8) to see how
the 56 Cl(8) Trivector elements correspond to the 56 Fr3(O) elements.



To see how Fr3(O) gives String Theory look at one of the J3(O)o in Fr3(O)

One of the two 26D traceless J3(O)o parts of Fr3(O)

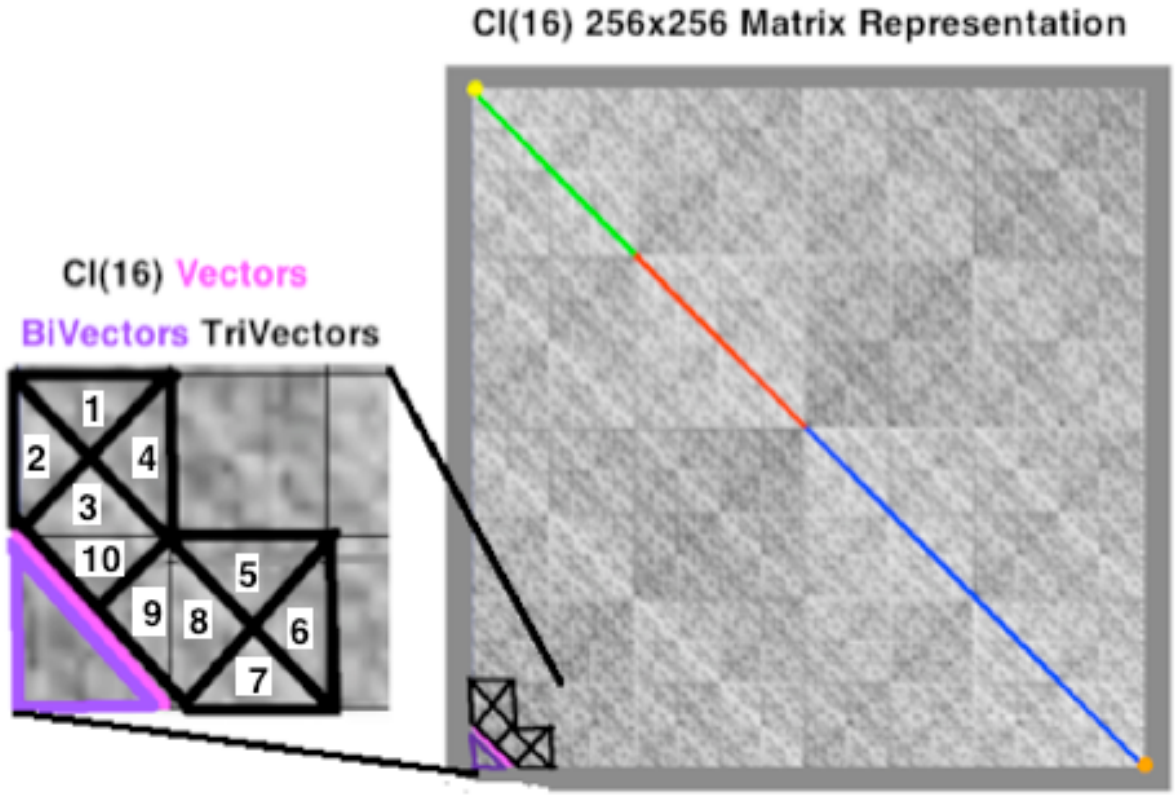
d	S+	V
S+*	-d-f	S-
V*	S-*	f

S+ = 8 First-Generation Fermion Particles
S- = 8 First-Generation Fermion AntiParticles

S+ and S- are Orbifolded in the 26D String Theory Space
leaving 26 - 16 = 10 dimensions of 8-dim V and 1-dim d and 1-dim f.

d and f act to make 10-dim V+d+f a Conformal Space over 8-dim V
with Octonionic symmetries Spin(1,9) = SL2(O) and Spin(0,8) = Spin(1,7)
due to the Clifford Algebra isomorphism Cl(0,8) = Cl(1,7) = M16(R)

At the level of 26D World-Line=String Theory V+d+f = 10 so that
the String Spacetime is a Superposition of 10 E8 Lattices,
7 Integral Domains + 1 Kirmse's Mistake for V
and two more E8 Lattices for Conformal d and f
so that 560-dim Cl(16) TriVectors = 10 copies of 56-dim Fr3(O)



When Octonionic symmetry is broken to Quaternionic
Cl0,8) = Cl(1,7) = M16(R) is broken to Cl(2,6) = M8(H)
which contains Cl(2,4) = M4(H) with Conformal Spin(2,4) = SU(2,2)
so
the 10-dim V+d+f breaks to Cnf(2,4) + CP2
where Cnf(2,4) = 6-dim Vector Space of Conformal Cl(2,4)
and CP2 = SU(3) / SU(2) x U(1) = Compact Internal Symmetry Space
carrying the Gauge Group symmetries of the Standard Model.

By Twistor Correspondences 6-dim Vector Space of Conformal Cl(2,4)
contains 4-dim M4 Minkowski Physical Spacetime
so that our experiments see Spacetime as Kaluza-Klein M4 x CP2
and 8-dim V is effectively M4 x CP2 Kaluza-Klein.

In this Physics Model, with Fermions propagating in Spacetime,
Strings are physically interpreted as World-Lines, according to
David Finkelstein's idea ("Space-Time Code. III" Phys. Rev. D (1972) 2922-2931)
"... According to relativity, the world is a collection of processes (events} with an unexpectedly unified causal or chronological structure. Then an object is secondary ... [to]... a long causal sequence of processes, world line. ... [if] we assemble these ... into chromosomelike code sequences ... and braid and cross-link these strands to make more complex objects and their interactions ...[then]... The idea of the quantum jump comes into its own, and reigns supreme, even over space and time. ...".

Andrew Gray (quant-ph/9712037v2) said:
"... A new formulation of quantum mechanics ... assign[s] ... probabilities ...
to entire fine-grained histories ... [It] is fully relativistic and applicable to multi-particle systems ...[and]... makes the same experimental predictions as quantum field theory ...
consider space and time cut up into small volume elements
... and then take the limit as ... volume ... ---> 0 ...
get the final amplitude ... by considering all possible distributions at a time t earlier ...
for each such distribution the amplitude for it to occur [is] multiplied by the amplitude to get ... the final distribution ... the interference factor ... is a measure of how much interference between the different possible histories that contain the distribution of interest there is at each time ... This result is the ...
Feynman amplitude squared times the product of all the interference factors ...".

Luis E. Ibanez and Angel M. Uranga in "String Theory and Particle Physics" said:
"... String theory proposes ... small one-dimensional extended objects, strings,
of typical size Ls = 1/ Ms, with Ms known as the string scale ...
As a string evolves in time, it sweeps out a two-dimensional surface in spacetime, known as the worldsheet, which is the analog of the ... worldline of a point particle ...
for the bosonic string theory ... the classical string action is the total area spanned by the worldsheet ... This is the ... Nambu– Goto action ...".
Consider the Gray Fine-Grained History to be a World-Line String.

The Gray Fine-Grained History Quantum Theory
is equivalent to
the Nambu-Goto action of 26D String Theory.
Nambu-Goto 24x24 traceless spin-2 particle
is
Quantum Bohmion carrier of Bohm Quantum Potential

Further, Ibanez and Uranga also said:
"... The string groundstate corresponds to a 26d spacetime tachyonic scalar field T(x).
This **tachyon** ... is ... unstable
...
The massless two-index tensor splits into irreducible representations of SO(24) ...
Its **trace** corresponds to a scalar field, the dilaton **ϕ**, whose vev fixes the string interaction coupling constant gs
...
the **antisymmetric** part is the 26d 2-form field BMN
...
The **symmetric traceless** part is ... 26d ...".

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

Joe Polchinski in "String Theory, Volume 1, An Introduction to the Bosonic String" said:
"... we find at m^2 = - 4 / alpha' the **tachyon**,
and at m^2 = 0 the 24 x 24 states
of the [**traceless symmetric tensor**], **dilaton**, and **antisymmetric tensor** ...".

Here is how the 26D World-Line=String Theory is constructed

Step 1:
Consider the 26 Dimensions of Bosonic String Theory as
a 26-dimensional traceless part J3(O)o living inside a Fr3(O)

a	O+	Ov
O+*	b	O-
Ov*	O-*	-a-b

(where Ov, O+, and O- are in Octonion space with basis {1,i,j,k,E,I,J,K}
and a and b are real numbers with basis {1})
of the 27-dimensional Jordan algebra J3(O) of 3x3 Hermitian Octonion matrices.

Step 2:
Take a 3-brane to correspond to the Imaginary Quaternionic associative subspace spanned by {i,j,k} in the 8-dimensional Octonionic Ov space.

Step 3:
Compactify the 4-dimensional co-associative subspace spanned by {E,I,J,K} in the Octonionic Ov space as a CP2 = SU(3)/U(2), with its 4 world-brane scalars corresponding to the 4 covariant components of a Higgs scalar.
Add this subspace to the 3-brane, to get a 7-brane.

Step 4:
Orbifold the 1-dimensional Real subspace spanned by {1} in the Octonionic Ov space by the discrete multiplicative group Z2 = {-1,+1}, with its fixed points {-1,+1} corresponding to past and future time. This discretizes time steps and gets rid of the world-brane scalar corresponding to the subspace spanned by {1} in Ov. It also gives our brane a 2-level timelike structure, so that its past can connect to the future of a preceding brane and its future can connect to the past of a succeeding brane.
Add this subspace to the 7-brane, to get an 8-brane Spacetime Superposition.
Our basic 8-brane looks like two layers (past and future) of 7-branes.
Beyond the 8-brane our String Theory has 26 - 8 = 18 dimensions,
of which 25 - 8 = 17 have corresponding world-brane scalars:

8 world-brane scalars for Octonionic O+ space;
8 world-brane scalars for Octonionic O- space;
1 world-brane scalars for real a space;
and 1 dimension, for real b space, in which 8-branes containing spacelike 3-branes are stacked in timelike order.

Step 5:
To get rid of the world-brane scalars corresponding to the Octonionic O+ space, orbifold it by the 16-element discrete multiplicative group

Oct16 = {+/-1,+/-i,+/-j,+/-k,+/-E,+/-I,+/-J,+/-K}

to reduce O+ to 16 singular points {-1,-i,-j,-k,-E,-I,-J,-K,+1,+i,+j,+k,+E,+I,+J,+K}.
Let the 8 O+ singular points {-1,-i,-j,-k,-E,-I,-J,-K} correspond to
the fundamental fermion particles
{neutrino, red up quark, green up quark, blue up quark,
electron, red down quark, green down quark, blue down quark}
located on the past 7-brane layer of the 8-brane.
Let the 8 O+ singular points {+1,+i,+j,+k,+E,+I,+J,+K} correspond to
the fundamental fermion particles
{neutrino, red up quark, green up quark, blue up quark,
electron, red down quark, green down quark, blue down quark}
located on the future 7-brane layer of the 8-brane.
The 8 components of the 8 fundamental first-generation fermion particles = 8x8 = 64 correspond to the 64 of the 128-dim half-spinor 8-brane part of E8.
This gets rid of the 8 world-brane scalars corresponding to O+, and leaves:

8 world-brane scalars for Octonionic O- space;
1 world-brane scalars for real a space;
and 1 dimension, for real b space, in which 8-branes containing spacelike 3-branes are stacked in timelike order.

Step 6:
To get rid of the world-brane scalars corresponding to the Octonionic O- space, orbifold it by the 16-element discrete multiplicative group

Oct16 = {+/-1,+/-i,+/-j,+/-k,+/-E,+/-I,+/-J,+/-K}

to reduce O- to 16 singular points {-1,-i,-j,-k,-E,-I,-J,-K,+1,+i,+j,+k,+E,+I,+J,+K}.

Let the 8 O- singular points {-1,-i,-j,-k,-E,-I,-J,-K} correspond to the fundamental fermion anti-particles {anti-neutrino, red up anti-quark, green up anti-quark, blue up anti-quark, positron, red down anti-quark, green down anti-quark, blue down anti-quark}
located on the past 7-brane layer of D8.

Let the 8 O- singular points {+1,+i,+j,+k,+E,+I,+J,+K} correspond to the fundamental fermion anti-particles {anti-neutrino, red up anti-quark, green up anti-quark, blue up antiquark,
positron, red down anti-quark, green down anti-quark, blue down anti-quark}
located on the future 7-brane layer of the 8-brane.

The 8 components of 8 fundamental first-generation fermion anti-particles = 8x8 = 64 correspond to the 64 of the 128-dim half-spinor 8-brane part of E8.
This gets rid of the 8 world-brane scalars corresponding to O-, and leaves:

1 world-brane scalars for real a space;
and
1 dimension, for real b space, in which 8-branes containing spacelike 3-branes are stacked in timelike order.

Step 7:

Let the 1 world-brane scalar for real a space correspond to a Bohm-type Quantum Potential acting on strings in the stack of 8-branes.
Interpret strings as world-lines in the Many-Worlds, short strings representing virtual particles and loops.

Step 8:
Fundamentally, physics is described on HyperDiamond Lattice structures.
There are 7 independent E8 lattice Integral Domains, each corresponding to one of the 7 imaginary octionions. denoted by iE8, jE8, kE8, EE8, IE8, JE8, and KE8 and related to 8-brane adjoint and half-spinor parts of E8 and with 240 first-shell vertices.
An 8th 8-dim lattice 1E8 (not an Integral Domain) with 240 first-shell vertices related to the E8 adjoint part of E8 is related to the 7 octonion imaginary lattices.
Give each 8-brane structure based on Planck-scale E8 lattices so that
each 8-brane is a superposition/intersection/coincidence of the eight E8 lattices.
(see viXra 1301.0150)

Step 9:
Since Polchinski says "... If r D-branes coincide ... there are r^2 vectors, forming the adjoint of a U(r) gauge group ...", make the following assignments:

a gauge boson emanating from the 8-brane from its 1E8 and EE8 lattices is an SU(2)xU(1) ElectroWeak boson accounting for the photon and W+, W- and Z0 bosons.

a gauge boson emanating from the 8-brane from its IE8, JE8, and KE8 lattices is a SU(3) Color Gluon boson thus accounting for the 8 Color Force Gluon bosons.

The 4+8 = 12 bosons of the Standard Model Electroweak and Color forces correspond to 12 of the 28 dimensions of 28-dim Spin(8)
that corresponds to one of the 28 of the 120-dim adjoint 8-brane parts of E8.

a gauge boson emanating from the 8-brane from its 1E8, iE8, jE8, and kE8 lattices is a U(2,2) boson for conformal U(2,2) = Spin(2,4)xU(1) MacDowell-Mansouri gravity plus conformal structures consistent with the Higgs mechanism and with observed Dark Energy, Dark Matter, and Ordinary matter.

The 16-dim U(2,2) is a subgroup of 28-dim Spin(2,6)
that corresponds to the other 28 of the 120-dim adjoint 8-brane part of E8.

Step 10:
Since Polchinski says
"... there will also be r^2 massless scalars from
the components normal to the D-brane. ...
the collective coordinates ... X^u ... for the embedding
of n D-branes in spacetime are now enlarged to nxn matrices.
This 'noncommutative geometry' ...[may be]... an important hint
about the nature of spacetime. ...",

make the following assignment:
The 8x8 matrices for the collective coordinates
linking an 8-brane to the next 8-brane in the stack
are needed to connect the eight E8 lattices of the 8-brane
to the eight E8 lattices of the next 8-brane in the stack.
The 8x8 = 64 correspond to the 64 of the 120 adjoint 8-brane part of E8.

We have now accounted for all the scalars and
have shown that the model has the physics content of the realistic E8 Physics model
with Lagrangian structure based on E8 = (28 + 28 + 64) + (64 + 64)
and
AQFT structure of Cl(1,25) of 26D String Theory with real Clifford Algebra periodicity
that is a generalized Hyperfinite II1 von Neumann factor algebra
that is the completion of the union of all tensor products of Cl(1,25).

Tachyons localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions and so produce Schwinger Sources.

When a fermion particle/antiparticle appears in E8 spacetime it does not remain a single Planck-scale entity because **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 Source**.
Its **structure comes from the 24-dim Leech lattice part of the Monster Group which is**

2^(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.

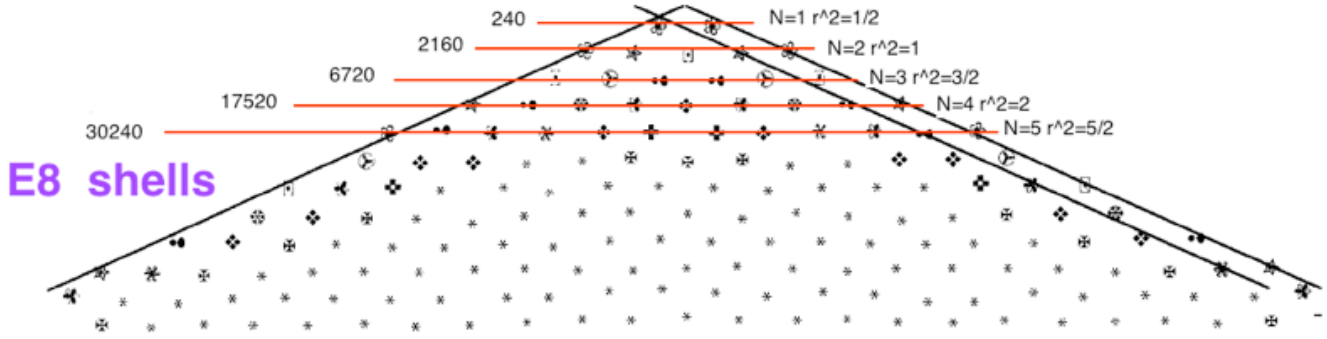
The volume of the Kerr-Newman Cloud is on the order of 10^27 x Planck scale, so the Kerr-Newman Cloud **Source should contain about 10^27 particle/antiparticle pairs and its size should be about** 10^(27/3) x 1.6 x 10^(-33) cm = roughly **10^(-24) cm**.

Schwinger Source QuasiCrystal Internal Structure

Above the scale of Schwinger Sources (10^(-24) cm) E8-Cl(16) Physics structures such as Spacetime, Symmetric Spaces, and Bounded Complex Domains and their Shilov Boundaries, are well approximated by smooth manifolds so that the geometric techniques of Amand Wyler give good results for force strengths, particle masses, etc.

Below the scale of Schwinger Sources (10^(-24) cm down to Planck 10^(-33) cm) the fundamental structures are E8 lattices and QuasiCrystals derived therefrom.
Planck Scale is about 10^(-33) cm. Schwinger Source Scale is about 10^(-24) cm,
a scale about 10^9 larger than the Planck Scale.

This mapping of the shell structure of a full E8 Lattice
is adapted from the book “Geometrical Frustration” by Sadoc and Mosseri



{335} "720" "1440" "3600" "3840" "7200"

{533} "1200" "2400" "2400"+{335} "3600"+{335} * "not determined"

120+120 = 240

120+600+720+600+120 = 2160

720+1200+1440+1440+1200+720 = 6720

600+1440+(2400+120)+2400+3600+2400+(2400+120)+1440+600 = 17520

120+1440+2400+(3600+120)+3600+3840+3840+3600+(3600+120)+2400+1440+120 = 30240

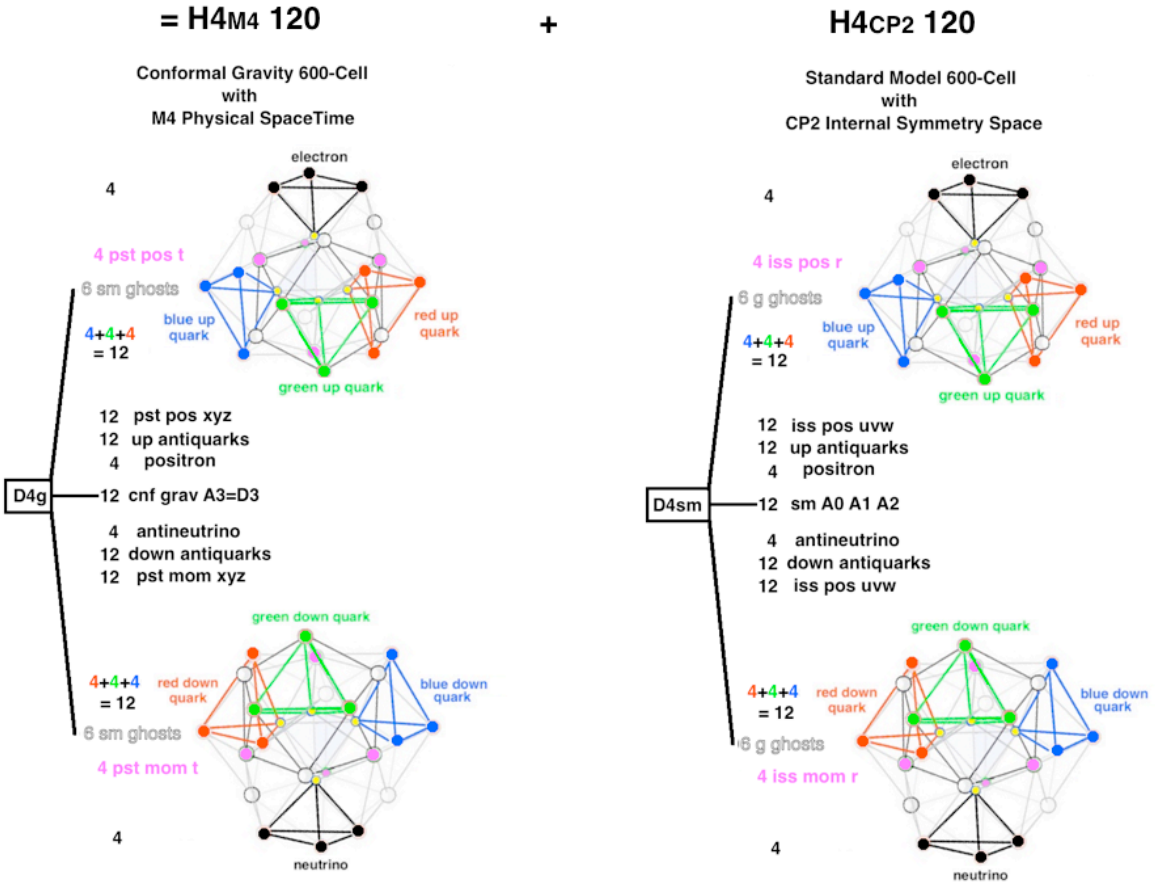
How to Visualize a Schwinger Source in 7 Steps:

First, look at the 240-vertex E8 Root Vector representation of the Valence Fermion of the Schwinger Source Cloud. It is two 600-cells, each with 120 vertices:

H4 M4 representing Conformal Gravity and the M4 part of M4 x CP2 Kaluza-Klein
where M4 = 4D Minkowski Physical Spacetime and
H4 CP2 representing the Standard Model and the CP2 part of M4 x CP2
where CP2 = SU(3) / SU(2) x U(1) Internal Symmetry Space

The H4 M4 600-cell is larger than the H4 CP2 600-cell by the Golden Ratio

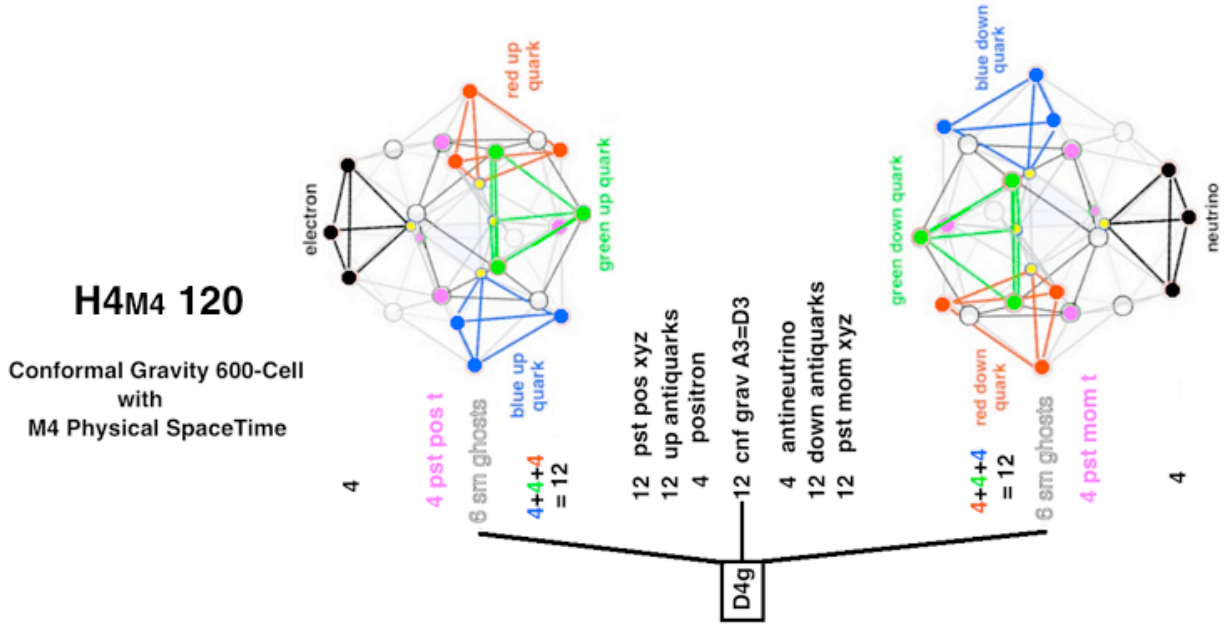
E8 240 Root Vectors =



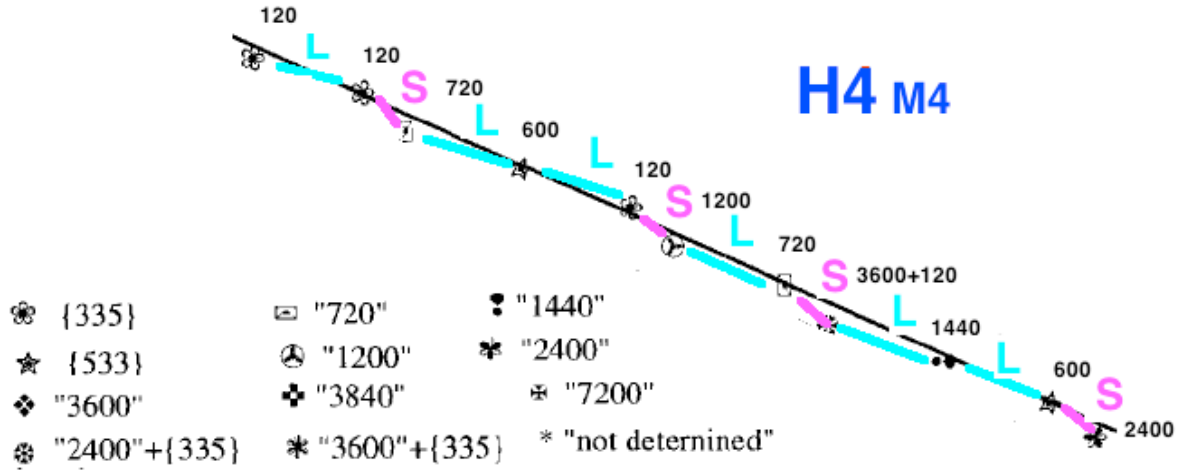
Each First-Generation Fermion is represented by a 4-vertex Tetrahedron in the H4 M4 600-cell and in the H4 CP2 600-cell.

The Valence Fermion is represented as the corresponding two Tetrahedra being activated.

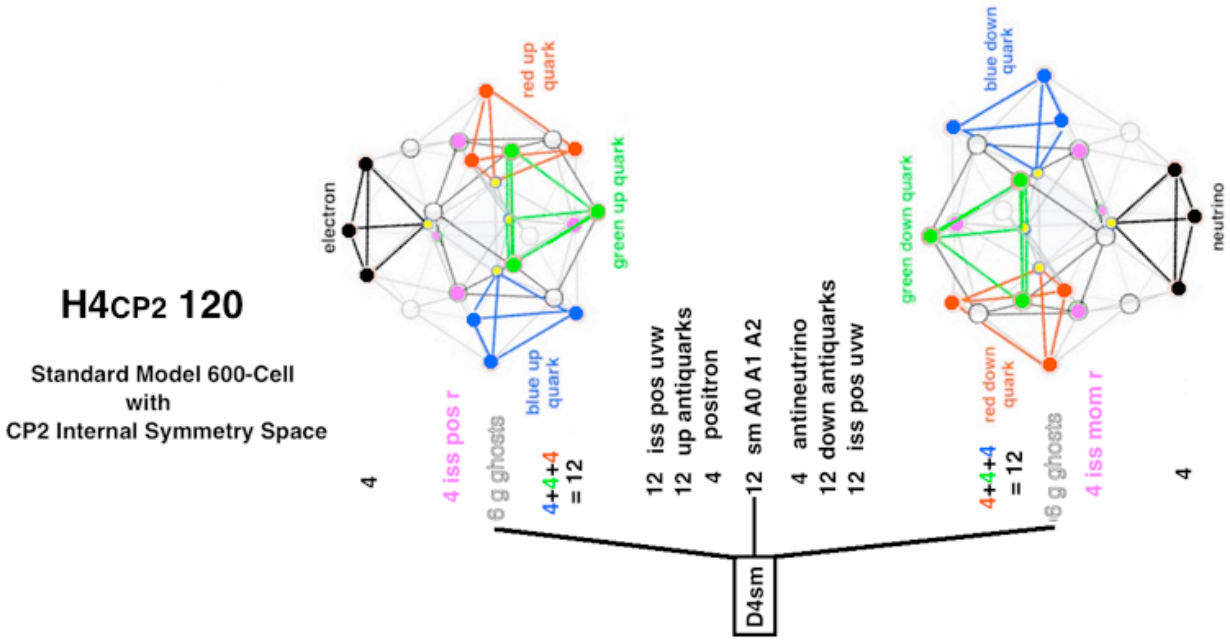
Second, look only at the H4 M4 600-cell to see how the Valence Fermion looks in M4 Minkowski Physical Spacetime:



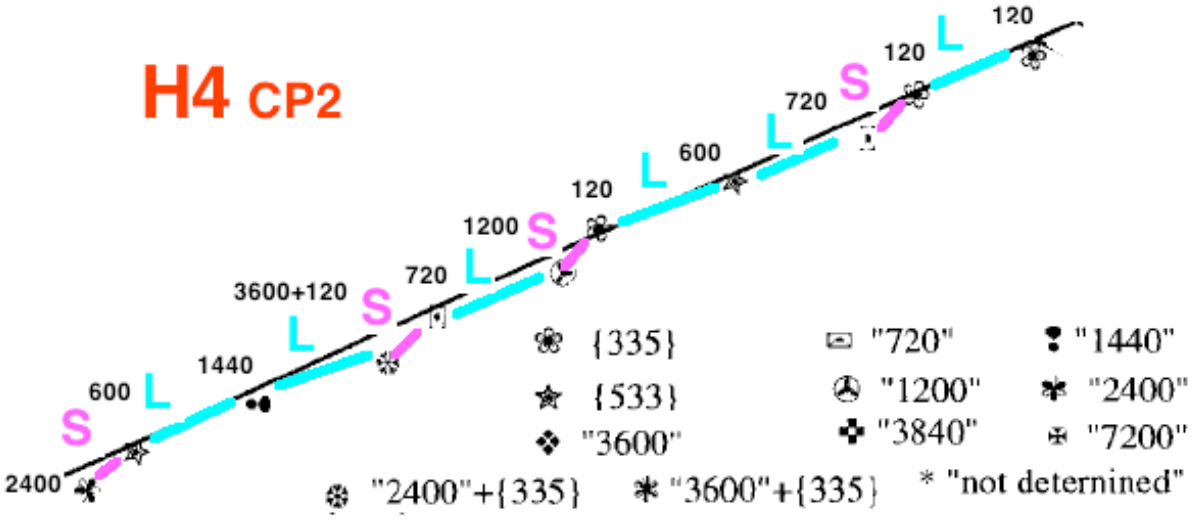
Third,
look at the Fibonacci Shell Structure of the M4 part of the Schwinger Source Cloud



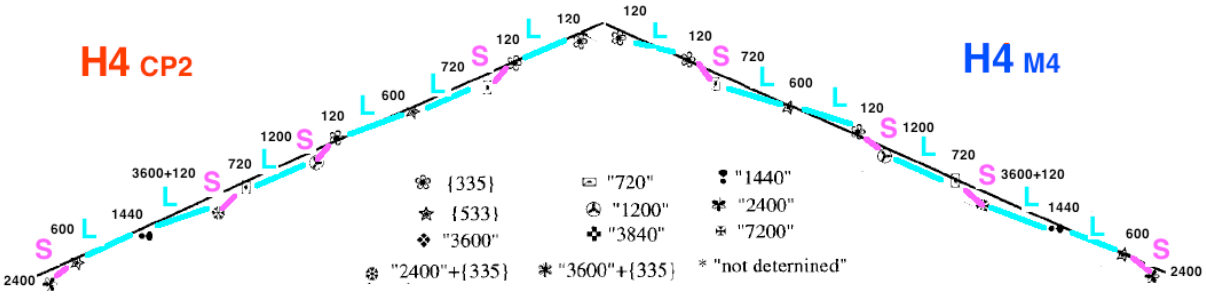
Fourth, look only at the H4 CP2 600-cell to see how the Valence Fermion looks in CP2 Internal Symmetry Space:



Fifth,
look at the Fibonacci Shell Structure of the CP2 part of the Schwinger Source Cloud

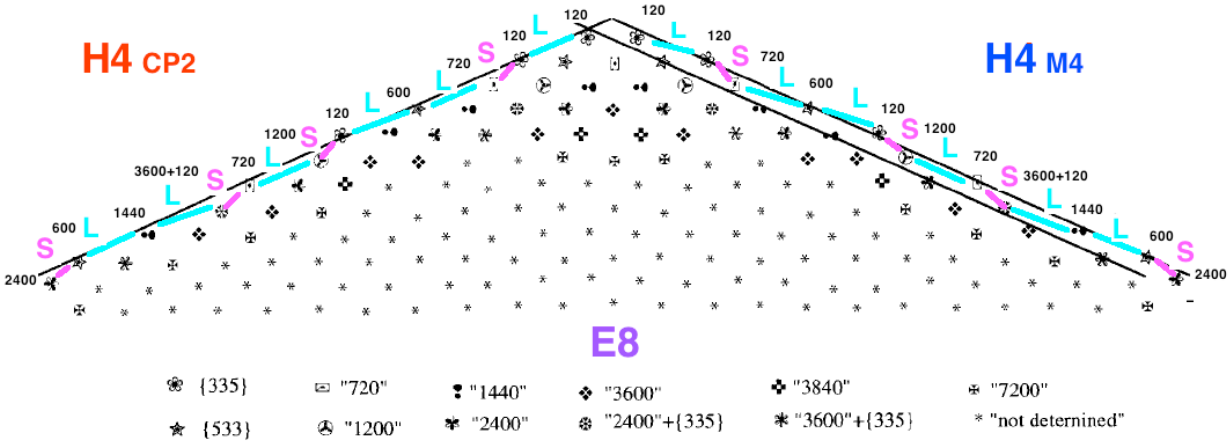


Sixth,
look at the combined Shell Structures of H4 M4 and H4 CP2:



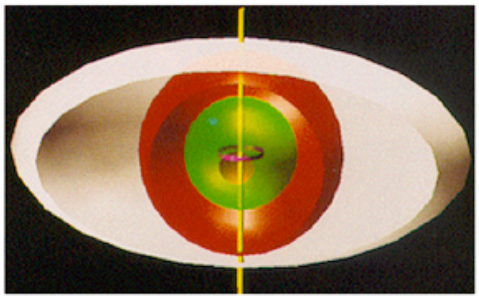
At this stage, you see the M4 and CP2 parts of the Schwinger Source Cloud
but
you have not yet seen the full E8 Schwinger Source Cloud.
For that, you need to go to the 7th Step:

Seventh,
combine the H4 M4 and H4 CP2 parts to form the full E8 Schwinger Source:



How does the Schwinger Source look on larger scales ?

In the 4D M4 MInkowski Physical Spacetime part of M4 x CP2 Kaluza-Klein
it looks like a Gravitational Black Hole.



Ergosphere (white), Outer Event Horizon (red), Inner Event Horizon (green), and Ring Singularity (purple)
from Black Holes - A Traveller's Guide, by Clifford Pickover (Wiley 1996).

David Finkelstein invented the one-way membrane of the Black Hole.
David's Black Hole can be generalized to deal with Spin
and the. (-1 +1) Charge of the U(2) ElectroWeak Force

The generalization is called a Kerr-Newman Black Hole,

The Zeldovich-Hawking Process,
in which a Virtual Particle-AntiParticle Pair near the Event Horizon can be separated
with one of the Virtual Pair going into the Black Hole
and
the other going into External Spacetime,

can be applied to Quark-AntiQuark Virtual Pairs showing that

a Black Hole can carry Color Charge of the SU(3) Color Force.

Quantum Kernel Functions, Schwinger Source Green's Functions, Hua Geometry, and Wyler Calculations

Fock "Fundamental of Quantum Mechanics" (1931) showed that Quantum requires Linear Operators "... represented by a definite integral [of a]... kernel ... function ...".

Schwinger (1951 - see Schweber, PNAS 102, 7783-7788) "... introduced a description in terms of Green's functions, what Feynman had called propagators ... The Green's functions are vacuum expectation values of time-ordered Heisenberg operators, and the field theory can be defined non-perturbatively in terms of these functions ...[which]... gave deep structural insights into QFTs; in particular ... the structure of the Green's functions when their variables are analytically continued to complex values ...".

Wolf (J. Math. Mech 14 (1965) 1033-1047) showed that the Classical Domains (complete simply connected Riemannian symmetric spaces) representing 4-dim Spacetime with Quaternionic Structure are:
S4 = 4-sphere = Spin(5) / Spin(4) where Spin(5) = Schwinger-Euclidean version of the Anti-DeSitter subgroup of the Conformal Group that gives MacDowell-Mansouiri Gravity
CP2 = complex projective 2-space = SU(3) / U(2) with the SU(3) of the Color Force
S2 x S2 = SU(2)/U(1) x SU(2)/U(1) with two copies of the SU(2) of the Weak Force
S1 x S1 x S1 x S1 = U(1) x U(1) x U(1) x U(1) = 4 copies of the U(1) of the EM Photon
(1 copy for each of the 4 covariant components of the Photon)

Hua "Harmonic Analysis of Functions of Several Complex Variables in the Classical Domains" (1958) showed Kernel Functions for Complex Classical Domains and calculated compact volumes (such as Euclidean spacetime) whose ratios correspond to ratios of measures of noncompact spaces (such as hyperbolic signature spacetime). Here M = Spacetime Structure and D = Gauge Domain and Q = Shilov Boundary of D:

Force	M	Vol(M)
gravity	S^4	8pi^2/3 - S^4 is 4-dimensional
color	CP^2	8pi^2/3 - CP^2 is 4-dimensional
weak	S^2 x S^2	2 x 4pi - S^2 is a 2-dim boundary of 3-dim ball
		4-dim S^2 x S^2 = topological boundary of 6-dim 2-polyball
		Shilov Boundary of 6-dim 2-polyball = S^2 + S^2 =
		= 2-dim surface frame of 4-dim S^2 x S^
e-mag	T^4	4 x 2pi - S^1 is 1-dim boundary of 2-dim disk
	4-dim T^4 = S^1 x S^1 x S^1 x S^1 = topological boundary of 8-dim 4-polydisk	
	Shilov Boundary of 8-dim 4-polydisk = S^1 + S^1 + S^1 + S^1 =	
	= 1-dim wire frame of 4-dim T^4	

Force	M	Vol(M)	Q	Vol(Q)	D	Vol(D)
gravity	S^4	8pi^2/3	RP^1xS^4	8pi^3/3	IV5	pi^5/2^4 5!
color	CP^2	8pi^2/3	S^5	4pi^3	B^6(ball)	pi^3/6
Weak	S^2xS^2	2x4pi	RP^1xS^2	4pi^2	IV3	pi^3/24

e-mag T^4 4x2pi - - - -

Armand Wyler (1971 - C. R. Acad. Sc. Paris, t. 271, 186-188) showed how to use Green's Functions = Kernel Functions of Classical Domain structures characterizing Sources = Leptons, Quarks, and Gauge Bosons, to calculate Particle Mass and **Force Strength = (1 / Mforce^2) (Vol(M) (Vol(Q) / Vol(D)^(1 / mforce))**

where Mforce = characteristic mass (Planck for Gravity, Weak Bosons for Weak)

Gauge Group	Force	Characteristic Energy Level	Geometric Strength	Full Strength
Spin(5)	gravity	approx 10^19 GeV	1	GGmproton^2 approx 5 x 10^-39
SU(3)	color	approx 245 MeV	0.6286	0.6286
SU(2)	weak	approx 100 GeV	0.2535	GWmproton^2 approx 1.05 x 10^-5
U(1)	e-mag	approx 4 KeV	1/137.03608	1/137.03608

Schwinger (1969 - see physics/0610054) said: "... operator field theory ... replace[s] the particle with ... properties ... distributed througout ... small volumes of three-dimensional space ... particles ... must be created ... even though we vary a number of experimental parameters ... The properties of the particle ... remain the same ... We introduce a quantitative description of the particle source in terms of a source function ... we do not have to claim that we can make the source arbitrarily small ... the experimeter... must detect the particles ...[by]... collision that annihilates the particle ... the source ... can be ... an abstraction of an annilhilation collision, with the source acting negatively, as a sink ... The basic things are ... the source functions ... describing the intermediate propagation of the particle ...".

Schwinger Sources can be described by continuous manifold structures of Bounded Complex Domains and their Shilov Boundaries

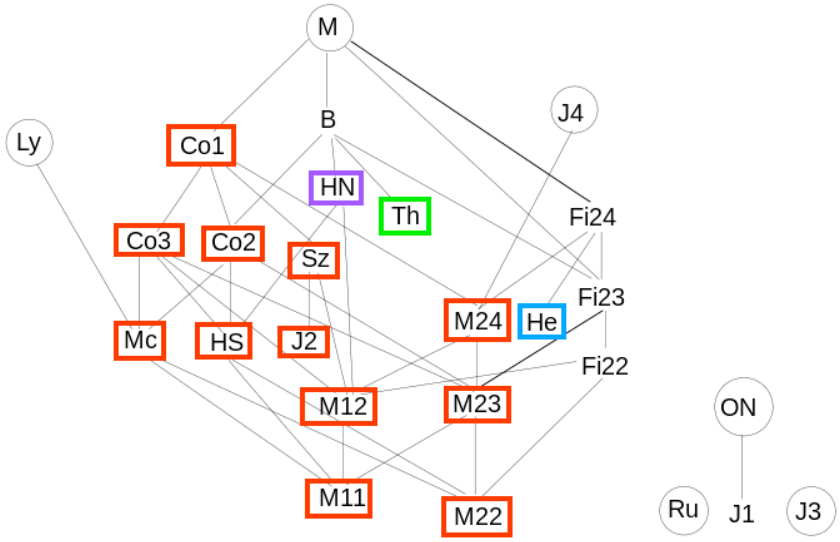
but

E8 Physics at the Planck Scale has spacetime condensing out of Clifford structures forming a 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 a single 26-dim String Theory cell modulo the Leech lattice is the Monster Group of order about 8 x 10^53.

The Monster Group is of order
8080 , 17424, 79451, 28758, 86459, 90496, 17107, 57005, 75436, 80000, 00000
=
2^46 . 3^20 . 5^9 . 7^6 . 11^2 . 13^3 . 17. 19. 23. 29. 31. 41. 47. 59 . 71
or about 8 x 10^53

This chart (from Wikipedia) shows the Monster M and other Sporadic Finite Groups



Co1 x Th x He x HN / HS together have order about 4 x 9 x 4 x 10^(18+16+9+7)
= about 10^52

The order of Co1 is 2^21.3^9.5^4.7^2.11.13.23 or about 4 x 10^18.
Aut(Leech Lattice) = double cover of Co1.
The order of the double cover 2.Co1 is 2^22.3^9.5^4.7^2.11.13.23 or about 0.8 x 10^19.

Taking into account the non-sporadic part of the Leech Lattice symmetry
according to the ATLAS at brauer.maths.qmul.ac.uk/Atlas/v3/spor/M/
the Schwinger Source Kerr-Newman Cloud Symmetry is 2^(1+24).Co1
of order 139511839126336328171520000 = 1.4 x 10^26

The components of the Monster Group describe the composition of Schwinger Sources:

Co1 gives the number of particles in the Schwinger Source Kerr-Newman Cloud emanating from a Valence particle in a Planck-scale cell of E8 Physics SpaceTime.

Th = Thompson Group. Wikipedia says "... Th ... acts on a vertex operator algebra over the field with 3 elements. This vertex operator algebra contains the E8 Lie algebra over **F**3, giving the embedding of Th into E8(3) ...". Th gives the 3-fold E8 Triality structure relating 8-dim SpaceTime to First-Generation Fermion Particles and AntiParticles.

He = Held Group. Wikipedia says "... The smallest faithful complex representation has dimension 51; there are two such representations that are duals of each other.
It centralizes an element of order 7 in the Monster group. ...".
He gives the 7-fold algebraically independent Octonion Imaginary E8 Integral Domains that make up 7 of the 8 components of Octonion Superposition E8 SpaceTime.

HN = Harada-Norton Group. Wikipedia says "... The prime 5 plays a special role ...
it centralizes an element of order 5 in ... the Monster group ...".
HN / HS gives the 5-fold symmetry of 120-element Binary Icosahedral E8 McKay Group beyond the 24-element Binary Tetrahedral E6 McKay Group at which level
the Shilov Boundaries of Bounded Complex Domains emerge to describe SpaceTime and Force Strengths and Particle Masses.

When a fermion particle/antiparticle appears in E8 spacetime
it does not remain a single Planck-scale entity
because 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 Kerr-Newman cloud constitutes the E8 Physics model Schwinger Source.

The cloud structure comes from the 24-dim Leech lattice part of the Monster Group which is 2^(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, so the volume of the Kerr-Newman Cloud is on the order of 10^27 x Planck scale and the Kerr-Newman Cloud should contain about 10^27 particle/antiparticle pairs. Its size should be about 10^(27/3) x 1.6 x 10^(-33) cm = roughly 10^(-24) cm.

Each of those particle-antiparticle pairs should see (with Bohm Potential)
the rest of our Universe in the perspective of 8 x 10^53 Monster Symmetry
so a single Schwinger Source acting as a Jewel of Indra's Net should see / reflect

10^27 x 8 x 10^53 = 8 x 10^80 Other Schwinger Source Jewels of Indra's Net
which is consistent with the number of Schwinger Sources in our Universe.

Andrew Gray in arXiv quant-ph/9712037 said:
"... probabilites are ... assigned to entire fine-grained histories ...
base[d] ... on the Feynman path integral formulation ..."
so in E8 Physics the Indra's Net of Schwinger Source Jewels
would not have Bohm Quantum Potential interactions between two Jewels,
rather the interactions would be between the two entire World-Line History Strings

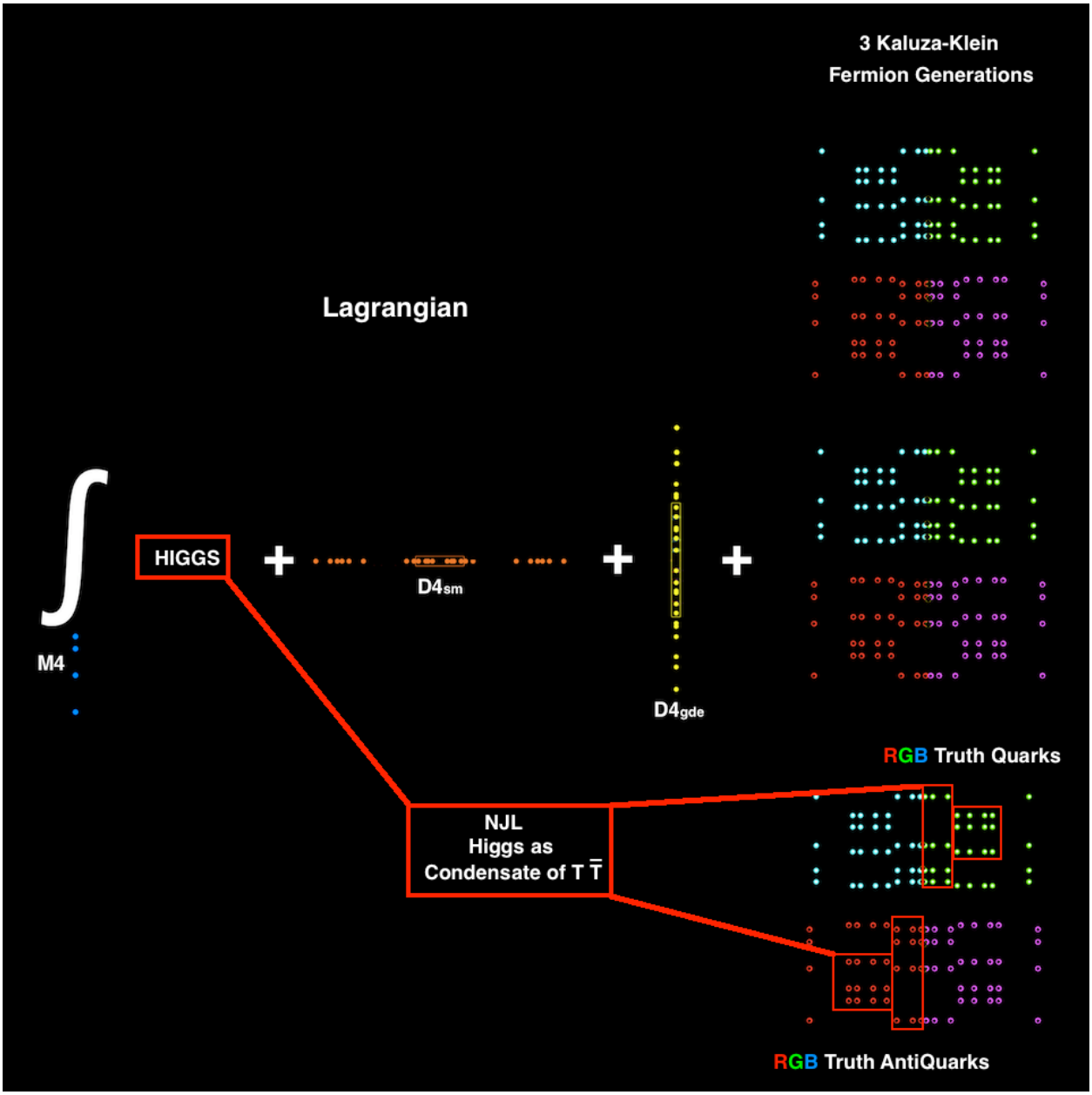
(image above and quote below from http://www.blockchaintechnologies.com/)

Each Node is a Schwinger Source that is connected by Bohm Quantum Potential
to all other Schwinger Source Nodes in our Universe
and governed by the "algorithms and rules" of the E8 Physics Lagrangian and AQFT
"... A **blockchain** is a type of distributed ledger, comprised of unchangable, digitally recorded data in packages called blocks. These digitally recorded "blocks" of data is stored in a linear chain ... A distributed ledger is a consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, and/or institutions ..."
or,

for **Cl(1,25) E8 Physics Indra's Net of Schwinger Source Jewels,**
spread across the entirety of our Universe.

The idea of **Schwinger Sources as more than mere points is in David Finkelstein's Space-Time Code 1968** in which David said "... **What is too simple about general relativity is the space-time point** ... each point of space-time is some kind of assembly of some kind of thing ... Each point, as Feynman once put it, has to remember with precision the values of indefinitely many fields describing many elementary particles; has to have data inputs and outputs connected to neighboring points; has to have a little arithmetic element to satisfy the field equations; and all in all might just as well be a complete computer ...".

Wyler Force Strength and Mass Calculation Details



The E8 model constructs the Lagrangian integral such that the mass m emerges as the integral over the Schwinger Source spacetime region of its Kerr-Newman cloud of virtual particle/antiparticle pairs plus the valence fermion so that the volume of the Schwinger Source fermion defines its mass, which, being dressed with the particle/antiparticle pair cloud, gives quark mass as constituent mass.

Fermion Schwinger Sources correspond to the Lie Sphere Symmetric space

Spin(10) / Spin(8)xU(1)

with Bounded Complex Domain D8 of type IV8 and Shilov Boundary Q8 = RP1 x S7 which has local symmetry of the Spin(8) gauge group from which the first generation spinor fermions are formed as +half-spinor and -half-spinor spaces

For the Gauge Gravity and Standard Model Gauge Bosons the process of breaking Octonionic 8-dim SpaceTime down to Quaternionic (4+4)-dim M4 x CP2 Kaluza-Klein creates differences in the way gauge bosons "see" 4-dim Physical SpaceTime.
There are 4 equivalence classes of 4-dimensional Riemannian Symmetric Spaces with Quaternionic structure consistent with 4-dim Physical SpaceTime:

S4 = 4-sphere = Spin(5) / Spin(4) where Spin(5) = Schwinger-Euclidean version of the Anti-DeSitter subgroup of the Conformal Group that gives MacDowell-Mansouiri Gravity

CP2 = complex projective 2-space = SU(3) / U(2) with the SU(3) of the Color Force

S2 x S2 = SU(2)/U(1) x SU(2)/U(1) with two copies of the SU(2) of the Weak Force

S1 x S1 x S1 x S1 = U(1) x U(1) x U(1) x U(1) = 4 copies of the U(1) of the EM Photon
(1 copy for each of the 4 covariant components of the Photon)

The Gravity Gauge Bosons (Schwinger-Euclidean versions) live in
a Spin(5) subalgebra of the Spin(6) Conformal subalgebra of D4 = Spin(8).
They "see" M4 Physical spacetime as the 4-sphere S4
so that their part of the Physical Lagrangian is

$$\int_{S4} \text{Gravity Gauge Boson Term}$$

an integral over SpaceTime S4.
The Schwinger Sources for GRb bosons are the Complex Bounded Domains and Shilov Boundaries for Spin(5) MacDowell-Mansouri Gravity bosons.
However, due to Stabilization of Condensate SpaceTime
by virtual Planck Mass Gravitational Black Holes,
for Gravity, the effective force strength that we see in our experiments
is not just composed of the S4 volume and the Spin(5) Schwinger Source volume,
but is suppressed by the square of the Planck Mass.
The unsuppressed Gravity force strength is the Geometric Part of the force strength.

The Standard Model SU(3) Color Force bosons live in
a SU(3) subalgebra of the SU(4) subalgebra of D4 = Spin(8).
They "see" M4 Physical spacetime as the complex projective plane CP2
so that their part of the Physical Lagrangian is

$$\int_{CP2} \text{SU(3) Color Force Gauge Boson Term}$$

an integral over SpaceTime CP2.
The Schwinger Sources for SU(3) bosons are the Complex Bounded Domains and Shilov Boundaries for SU(3) Color Force bosons. The Color Force Strength is given by the SpaceTime CP2 volume and the SU(3) Schwinger Source volume.
Note that since the Schwinger Source volume is dressed with the particle/antiparticle pair cloud, the calculated force strength is for the characteristic energy level of the Color Force (about 245 MeV).

The Standard Model SU(2) Weak Force bosons live in
a SU(2) subalgebra of the U(2) local group of CP2 = SU(3) / U(2)
They "see" M4 Physical spacetime as two 2-spheres S2 x S2
so that their part of the Physical Lagrangian is

$$\int_{S2xS2} \text{SU(2) Weak Force Gauge Boson Term}$$

an integral over SpaceTime S2xS2.
The Schwinger Sources for SU(2) bosons are the Complex Bounded Domains and Shilov Boundaries for SU(2) Weak Force bosons. However, due to the action of the Higgs mechanism, for the Weak Force, the effective force strength that we see in our experiments is not just composed of the S2xS2 volume and the SU(2) Schwinger Source volume, but is suppressed by the square of the Weak Boson masses.
The unsuppressed Weak Force strength is the Geometric Part of the force strength.

The Standard Model U(1) Electromagnetic Force bosons (photons) live in
a U(1) subalgebra of the U(2) local group of CP2 = SU(3) / U(2)
They "see" M4 Physical spacetime as four 1-sphere circles S1xS1xS1xS1 = T4
(T4 = 4-torus) so that their part of the Physical Lagrangian is

$$\int_{T4} \text{(U(1) Electromagnetism Gauge Boson Term}$$

an integral over SpaceTime T4.
The Schwinger Sources for U(1) photons are the Complex Bounded Domains and Shilov Boundaries for U(1) photons. The Electromagnetic Force Strength is given by the SpaceTime T4 volume and the U(1) Schwinger Source volume.

Force Strength and Boson Mass Calculation

The Force Strength is made up of two parts:
the relevant spacetime manifold of gauge group global action
and
the relevant symmetric space manifold of gauge group local action.

The 4-dim spacetime Lagrangian GG SM gauge boson term is:
the integral over spacetime as seen by gauge boson acting globally
of the gauge force term of the gauge boson acting locally
for the gauge bosons of each of the four forces:
U(1) for electromagnetism
SU(2) for weak force
SU(3) for color force
Spin(5) - compact version of antiDeSitter Spin(2,3) subgroup of Conformal Spin(2,4) for gravity by the MacDowell-Mansouri mechanism.

In the conventional picture,
for each gauge force the gauge boson force term contains the force strength,
which in Feynman's picture is the amplitude to emit a gauge boson,
and can also be thought of as the probability = square of amplitude,
in an explicit (like g |F|^2) or an implicit (incorporated into the |F|^2) form.
Either way, the conventional picture is that the force strength g is an ad hoc inclusion.

The E8 model does not put in force strength g ad hoc,
but constructs the integral such that
the force strength emerges naturally from the geometry of each gauge force.

To do that, for each gauge force:

1 - make the spacetime over which the integral is taken be spacetime as it is seen by that gauge boson, that is, in terms of the symmetric space with global symmetry of the gauge boson:
the U(1) photon sees 4-dim spacetime as T^4 = S1 x S1 X S1 x S1
the SU(2) weak boson sees 4-dim spacetime as S2 x S2
the SU(3) weak boson sees 4-dim spacetime as CP2
the Spin(5) of gravity sees 4-dim spacetime as S4

2 - make the gauge boson force term have the volume of the Shilov boundary corresponding to the symmetric space with local symmetry of the gauge boson.
The nontrivial Shilov boundaries are:
for SU(2) Shilov = RP^1xS^2
for SU(3) Shilov = S^5
for Spin(5) Shilov = RP^1xS^4

The result is (ignoring technicalities for exposition) the geometric factor for force strengths.

Each gauge group is the global symmetry of a symmetric space

S1 for U(1)
S2 = SU(2)/U(1) = Spin(3)/Spin(2) for SU(2)
CP2 = SU(3)/SU(2)xU(1) for SU(3)
S4 = Spin(5)/Spin(4) for Spin(5)

Each gauge group is the local symmetry of a symmetric space

U(1) for itself
SU(2) for Spin(5) / SU(2)xU(1)
SU(3) for SU(4) / SU(3)xU(1)
Spin(5) for Spin(7) / Spin(5)xU(1)

The nontrivial local symmetry symmetric spaces correspond to bounded complex domains

SU(2) for Spin(5) / SU(2)xU(1) corresponds to IV3
SU(3) for SU(4) / SU(3)xU(1) corresponds to B^6 (ball)
Spin(5) for Spin(7) / Spin(5)xU(1) corresponds to IV5

The nontrivial bounded complex domains have Shilov boundaries

SU(2) for Spin(5) / SU(2)xU(1) corresponds to IV3 Shilov = RP^1xS^2
SU(3) for SU(4) / SU(3)xU(1) corresponds to B^6 (ball) Shilov = S^5
Spin(5) for Spin(7) / Spin(5)xU(1) corresponds to IV5 Shilov = RP^1xS^4

Very roughly, think of the force strength as
integral over global symmetry space of physical (ie Shilov Boundary) volume =
= strength of the force.
That is:
the geometric strength of the force is given by the product of
the volume of a 4-dim thing with global symmetry of the force and
the volume of the Shilov Boundary for the local symmetry of the force.

When you calculate the product volumes (using some tricky normalization stuff),
you see that roughly:

Volume product for gravity is the largest volume
so since (as Feynman says) force strength = probability to emit a gauge boson means
that the highest force strength or probability should be 1
the gravity Volume product is normalized to be 1, and so (approximately):

Volume product for gravity = 1
Volume product for color = 2/3
Volume product for weak = 1/4
Volume product for electromagnetism = 1/137

There are two further main components of a force strength:

1 - for massive gauge bosons, a suppression by a factor of 1 / M^2

2 - renormalization running (important for color force)

Consider Massive Gauge Bosons:
Gravity as curvature deformation of SpaceTime, with SpaceTime as a condensate of Planck-Mass Black Holes, must be carried by virtual Planck-mass black holes, so that the geometric strength of gravity should be reduced by 1/Mp^2

The weak force is carried by weak bosons,
so that the geometric strength of the weak force should be reduced by 1/MW^2
That gives the result (approximate):

gravity strength = G (Newton's G)

color strength = 2/3

weak strength = G_F (Fermi's weak force G)

electromagnetism = 1/137

Consider Renormalization Running for the Color Force:: That gives the result:

gravity strength = G (Newton's G)

color strength = 1/10 at weak boson mass scale

weak strength = G_F (Fermi's weak force G)

electromagnetism = 1/137

The use of compact volumes is itself a calculational device, because it would be more nearly correct, instead of the integral over the compact global symmetry space of the compact physical (ie Shilov Boundary) volume=strength of the force to use the integral over the hyperbolic spacetime global symmetry space of the noncompact invariant measure of the gauge force term.

However, since the strongest (gravitation) geometric force strength is to be normalized to 1, the only thing that matters is ratios, and the compact volumes (finite and easy to look up in the book by Hua) have the same ratios as the noncompact invariant measures.

In fact, I should go on to say that continuous spacetime and gauge force geometric objects are themselves also calculational devices, and that it would be even more nearly correct to do the calculations with respect to a discrete generalized hyperdiamond Feynman checkerboard.

Here are more detailed force strength calculations:

The force strength of a given force is

alphaforce = (1 / Mforce^2) (Vol(MISforce)) (Vol(Qforce) / Vol(Dforce)^(1 / mforce))

where:

alphaforce represents the force strength;

Mforce represents the effective mass;

MISforce represents the relevant part of the target Internal Symmetry Space;

Vol(MISforce) stands for volume of MISforce and is sometimes also denoted by Vol(M);

Qforce represents the link from the origin to the relevant target for the gauge boson;

Vol(Qforce) stands for volume of Qforce;

Dforce represents the complex bounded homogeneous domain
of which Qforce is the Shilov boundary;

mforce is the dimensionality of Qforce, which is
4 for Gravity and the Color force,
2 for the Weak force (which therefore is considered to have two copies of QW for SpaceTime),
1 for Electromagnetism (which therefore is considered to have four copies of QE for SpaceTime)

Vol(Dforce)^(1 / mforce) 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).

The Qforce, Hermitian symmetric space, and Dforce manifolds for the four forces are:

Spin(5)	Spin(7) / Spin(5)xU(1)	IV5	4	RP^1xS^4
SU(3)	SU(4) / SU(3)xU(1)	B^6(ball)	4	S^5
SU(2)	Spin(5) / SU(2)xU(1)	IV3	2	RP^1xS^2
U(1)	-	-	1	-

The geometric volumes needed for the calculations are mostly taken from the book Harmonic Analysis of Functions of Several Complex Variables in the Classical Domains (AMS 1963, Moskva 1959, Science Press Peking 1958) by L. K. Hua [unit radius scale].

Force	M	Vol(M)
gravity	S^4	8pi^2/3 - S^4 is 4-dimensional
color	CP^2	8pi^2/3 - CP^2 is 4-dimensional
weak	S^2 x S^2	2 x 4pi - S^2 is a 2-dim boundary of 3-dim ball 4-dim S^2 x S^2 = topological boundary of 6-dim 2-polyball Shilov Boundary of 6-dim 2-polyball = S^2 + S^2 = = 2-dim surface frame of 4-dim S^2 x S^
e-mag	T^4	4 x 2pi - S^1 is 1-dim boundary of 2-dim disk 4-dim T^4 = S^1 x S^1 x S^1 x S^1 = topological boundary of 8-dim 4-polydisk Shilov Boundary of 8-dim 4-polydisk = S^1 + S^1 + S^1 + S^1 = = 1-dim wire frame of 4-dim T^4

Note (thanks to Carlos Castro for noticing this) also that the volume listed for CP2 is unconventional, but physically justified by noting that S4 and CP2 can be seen as having the same physical volume, with the only difference being structure at infinity.
Note that for U(1) electromagnetism, whose photon carries no charge, the factors Vol(Q) and Vol(D) do not apply and are set equal to 1, and from another point of view, the link manifold to the target vertex is trivial for the abelian neutral U(1) photons of Electromagnetism, so we take QE and DE to be equal to unity.

Force	M	Vol(M)	Q	Vol(Q)	D	Vol(D)
gravity	S^4	8pi^2/3	RP^1xS^4	8pi^3/3	IV5	pi^5/2^4 5!
color	CP^2	8pi^2/3	S^5	4pi^3	B^6(ball)	pi^3/6
Weak	S^2xS^2	2x4pi	RP^1xS^2	4pi^2	IV3	pi^3/24
e-mag	T^4	4x2pi	-	-	-	-

Note (thanks to Carlos Castro for noticing this) that the volume listed for S5 is for a squashed S5, a Shilov boundary of the complex domain corresponding to the symmetric space SU(4) / SU(3) x U(1).

Using the above numbers, the results of the calculations are the relative force strengths at the characteristic energy level of the generalized Bohr radius of each force:

Spin(5)	gravity	approx 10^19 GeV	1	GGmproton^2 approx 5 x 10^-39
SU(3)	color	approx 245 MeV	0.6286	0.6286
SU(2)	weak	approx 100 GeV	0.2535	GWmproton^2 approx 1.05 x 10^-5
U(1)	e-mag	approx 4 KeV	1/137.03608	1/137.03608

The force strengths are given at the characteristic energy levels of their forces, because the force strengths run with changing energy levels.
The effect is particularly pronounced with the color force.
The color force strength was calculated using a simple perturbative QCD renormalization group equation at various energies, with the following results:

Energy Level	Color Force Strength
245 MeV	0.6286
5.3 GeV	0.166
34 GeV	0.121
91 GeV	0.106

Taking other effects, such as Nonperturbative QCD, into account,
should give a Color Force Strength of about 0.125 at about 91 GeV

Higgs, W+, W-, Z0:

As with forces strengths, the calculations produce ratios of masses,
so that only one mass need be chosen to set the mass scale.

In the Cl(1,25) E8 model,
the value of the fundamental mass scale vacuum expectation value v = <PHI>
of the Higgs scalar field is set to be the sum of the physical masses of the weak bosons,
W+, W-, and Z0, whose tree-level masses will then be shown by ratio calculations to be
80.326 GeV, 80.326 GeV, and 91.862 GeV, respectively,
and therefore the electron mass will be 0.5110 MeV.

The relationship between the Higgs mass and v is given
by the Ginzburg-Landau term from the Mayer Mechanism as

$$(1/4)\ \mathrm{Tr}\ (\ [\ PHI\ ,\ PHI\ ]\ -\ PHI\ )^2$$

or, i
n the notation of quant-ph/9806009 by Guang-jiong Ni

$$(1/4!)\ \lambda\ PHI^4\ -\ (1/2)\ \sigma\ PHI^2$$

where the Higgs mass $M_H = \sqrt{2\ \sigma}$

Ni says:
"... the invariant meaning of the constant lambda in the Lagrangian is not the coupling constant, the latter will change after quantization ... The invariant meaning of lambda is nothing but the ratio of two mass scales:

$$\lambda = 3\ (\ M_H\ /\ PHI\ )^2$$

which remains unchanged irrespective of the order ...".

Since $\langle PHI \rangle^2 = v^2$, if v = 252.514 GeV and lambda = 1 for a single-mass-state Higgs,

$$1 = \sqrt{3}\ M_H\ /\ v \quad \text{so that} \quad M_H = 252.514\ /\ \sqrt{3} = 145.789\ \text{GeV}$$

However, for 3-mass-state Higgs as Nambu - Jona-Lasinio Tquark condensate
$\lambda = (\ \cos(\ \pi\ /\ 6\ )\ )^2 = 0.866^2$ we have

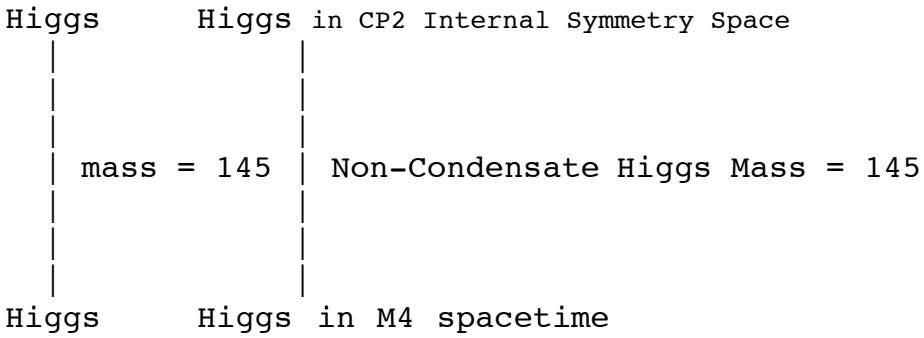
$$M_H^2\ /\ v^2 = (\ \cos(\ \pi\ /\ 6\ )\ )^2\ /\ 3$$

In E8 Physics, the fundamental mass scale vacuum expectation value v of the Higgs scalar field is the fundamental mass parameter that is to be set to define all other masses by the mass ratio formulas of the model and v is set to be 252.514 GeV
and we have

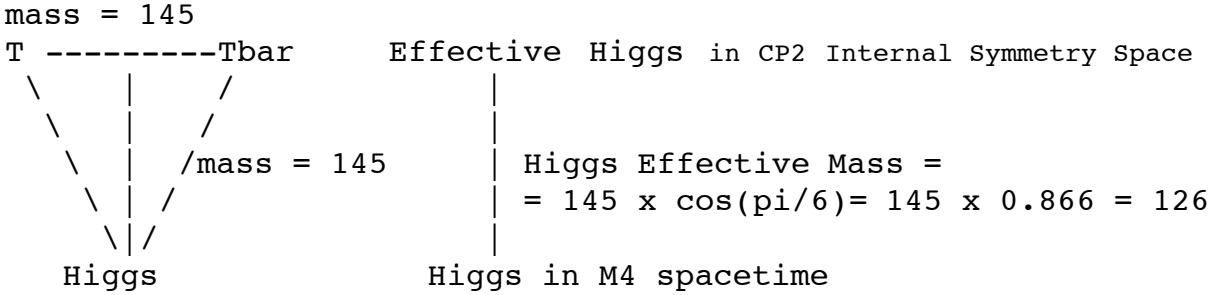
$$M_H = v\ \cos(\ \pi\ /\ 6\ )\ /\ \sqrt{(\ 1\ /\ 3\ )} = 126.257\ \text{GeV}$$

This is the value of the Low Mass State of the Higgs observed by the LHC.
MIddle and High Mass States come from a Higgs-Tquark Condensate System.
The Middle and High Mass States may have been observed by the LHC at 20% of the Low Mass State cross section, and that may be confirmed by the LHC 2015-1016 run.

A Non-Condensate Higgs is represented by a Higgs at a point in M4
that is connected to a Higgs representation in CP2 ISS by a line whose length
represents the Higgs mass with lambda = 1 = 1^2
and Higgs mass M_H = v /sqrt(3) = 145.789 GeV



However, in E8 Physics, the Higgs has structure of a Tquark condensate



in which the Higgs at a point in M4 is connected to a T and Tbar in CP2 ISS
so that the vertices of the Higgs-T-Tbar system are connected
by lines forming an equilateral triangle composed of 2 right triangles
(one from the CP2 origin to the T and to the M4 Higgs and
another from the CP2 origin to the Tbar and to the M4 Higgs).
In the T-quark condensate picture
lambda = 1^2 = lambda(T) + lambda(H) = (sin(pi / 6))^2 + (cos(pi / 6))^2
and
lambda(H) = (cos(pi / 6))^2

Therefore the Effective Higgs mass observed by LHC is:

Higgs Mass = 145.789 x cos(pi/6) = 126.257 GeV.

To get **W-boson masses**,
denote the 3 SU(2) high-energy weak bosons
(massless at energies higher than the electroweak unification)
by W+, W-, and W0,
corresponding to the massive physical weak bosons W+, W-, and Z0.

The triplet { W+, W-, W0 } couples directly with the T - Tbar quark-antiquark pair,
so that the total mass of the triplet { W+, W-, W0 } at the electroweak unification
is equal to the total mass of a T - Tbar pair, 259.031 GeV.

The triplet { W+, W-, Z0 } couples directly with the Higgs scalar,
which carries the Higgs mechanism by which the W0 becomes the physical Z0,
so that the total mass of the triplet { W+, W-, Z0 }
is equal to the vacuum expectation value v of the Higgs scalar field, v = 252.514 GeV.

What are individual masses of members of the triplet { W+, W-, Z0 } ?

First, look at the triplet { W+, W-, W0 } which can be represented by the 3-sphere S^3.
The Hopf fibration of S^3 as

S^1 --> S^3 --> S^2

gives a decomposition of the W bosons into the neutral W0 corresponding to S^1
and the charged pair W+ and W- corresponding to S^2.

The mass ratio of the sum of the masses of W+ and W- to the mass of W0
should be the volume ratio of the S^2 in S^3 to the S^1 in S3.
The unit sphere S^3 in R^4 is normalized by 1 / 2.
The unit sphere S^2 in R^3 is normalized by 1 / sqrt(3).
The unit sphere S^1 in R^2 is normalized by 1 / sqrt(2).
The ratio of the sum of the W+ and W- masses to the W0 mass should then be
(2 / sqrt3) V(S^2) / (2 / sqrt2) V(S^1) = 1.632993

Since the total mass of the triplet { W+, W-, W0 } is 259.031 GeV,
the total mass of a T - Tbar pair, and the charged weak bosons have equal mass,
we have

M_W+ = M_W- = 80.326 GeV and M_W0 = 98.379 GeV.

The charged W+/- neutrino-electron interchange must be symmetric
with the electron-neutrino interchange, so that the tree-level absence
of right-handed neutrino particles requires that

the charged W+/- SU(2) weak bosons act only on left-handed electrons.

Each gauge boson must act consistently on the entire Dirac fermion particle sector,
so that the
charged W+/- SU(2) weak bosons act only on left-handed fermion particles of all types.

The neutral W0 weak boson does not interchange Weyl neutrinos with Dirac fermions, and so is not restricted to left-handed fermions, but also has a component that acts on both types of fermions, both left-handed and right-handed, conserving parity.

However, the neutral W0 weak bosons are related to the charged W+/- weak bosons by custodial SU(2) symmetry, so that the left-handed component of the neutral W0 must be equal to the left-handed (entire) component of the charged W+/-.

Since the mass of the W0 is greater than the mass of the W+/-,
there remains for the W0 a component acting on both types of fermions.

Therefore the full W0 neutral weak boson interaction is proportional to
(M_W+/-^2 / M_W0^2) acting on left-handed fermions
and
(1 - (M_W+/-^2 / M_W0^2)) acting on both types of fermions.

If (1 - (M_W+/-2 / M_W0^2)) is defined to be sin(theta_w)^2 and denoted by K,
and if the strength of the W+/- charged weak force
(and of the custodial SU(2) symmetry) is denoted by T,
then the W0 neutral weak interaction can be written as W0L = T + K and W0LR = K.

Since the W0 acts as W0L with respect to the parity violating SU(2) weak force
and as W0LR with respect to the parity conserving U(1) electromagnetic force,
the W0 mass mW0 has two components:
the parity violating SU(2) part mW0L that is equal to M_W+/-
and the parity conserving part M_W0LR that acts like a heavy photon.

As M_W0 = 98.379 GeV = M_W0L + M_W0LR,
and as M_W0L = M_W+/- = 80.326 GeV, we have M_W0LR = 18.053 GeV.

Denote by *alphaE = *e^2 the force strength of the weak parity conserving U(1) electromagnetic type force that acts through the U(1) subgroup of SU(2).

The electromagnetic force strength alphaE = e^2 = 1 / 137.03608 was calculated above using the volume V(S^1) of an S^1 in R^2, normalized by 1 / sqrt(2).

The *alphaE force is part of the SU(2) weak force whose strength alphaW = w^2 was calculated above using the volume V(S^2) of an S^2 \subset R^3,
normalized by 1 / sqrt(3).

Also, the electromagnetic force strength alphaE = e^2 was calculated above using a 4-dimensional spacetime with global structure of the 4-torus T^4 made up of four S^1 1-spheres,
while the SU(2) weak force strength alphaW = w^2 was calculated above using two 2-spheres S^2 x S^2,
each of which contains one 1-sphere of the *alphaE force.

Therefore

*alphaE = alphaE (sqrt(2) / sqrt(3))(2 / 4) = alphaE / sqrt(6),

*e = e / (4th root of 6) = e / 1.565 ,

and

the mass mW0LR must be reduced to an effective value

M_W0LReff = M_W0LR / 1.565 = 18.053/1.565 = 11.536 GeV

for the *alphaE force to act like an electromagnetic force in the E8 model:

*e M_W0LR = e (1/5.65) M_W0LR = e M_Z0,

where the physical effective neutral weak boson is denoted by Z0.

Therefore, the correct Cl(1,25) E8 model values for weak boson masses
and the Weinberg angle theta_w are:

M_W+ = M_W- = 80.326 GeV;

M_Z0 = 80.326 + 11.536 = 91.862 GeV;

Sin(theta_w)^2 = 1 - (M_W+/- / M_Z0)^2 = 1 - (6452.2663 / 8438.6270) = 0.235.

Radiative corrections are not taken into account here, and may change these tree- level values somewhat.

Fermion Mass Calculations

In E8 Physics, the first generation spinor fermions are
seen as +half-spinor and -half-spinor spaces of Cl(1,7) = Cl(8).
Due to Triality,
Spin(8) can act on those 8-dimensional half-spinor spaces
similarly to the way it acts on 8-dimensional vector spacetime.

Take the the spinor fermion volume to be the Shilov boundary corresponding
to the same symmetric space on which Spin(8) acts as a local gauge group
that is used to construct 8-dimensional vector spacetime:
the symmetric space Spin(10) / Spin(8)xU(1)
corresponding to a bounded domain of type IV8
whose Shilov boundary is RP^1 x S^7

Since all first generation fermions see the spacetime over which the integral is
taken in the same way (unlike what happens for the force strength calculation),
the only geometric volume factor relevant for calculating first generation fermion
mass ratios is in the spinor fermion volume term.
E8 Physics Fermions correspond to Schwinger Sources,
so the quark mass in E8 Physics is a constituent mass.

Fermion masses are calculated as a product of four factors:

V(Qfermion) x N(Graviton) x N(octonion) x Sym

V(Qfermion) is the volume of the part of the half-spinor fermion particle manifold
S^7 x RP^1 related to the fermion particle by photon, weak boson, or gluon interactions.

N(Graviton) is the number of types of Spin(0,5) graviton related to the fermion.
The 10 gravitons correspond to the 10 infinitesimal generators of Spin(0,5) = Sp(2).
2 of them are in the Cartan subalgebra.
6 of them carry color charge, and therefore correspond to quarks.
The remaining 2 carry no color charge, but may carry electric charge and so
may be considered as corresponding to electrons.
One graviton takes the electron into itself, and the other can only take the first-
generation electron into the massless electron neutrino. Therefore only one graviton
should correspond to the mass of the first-generation electron. The graviton number
ratio of the down quark to the first-generation electron is therefore 6/1 = 6.

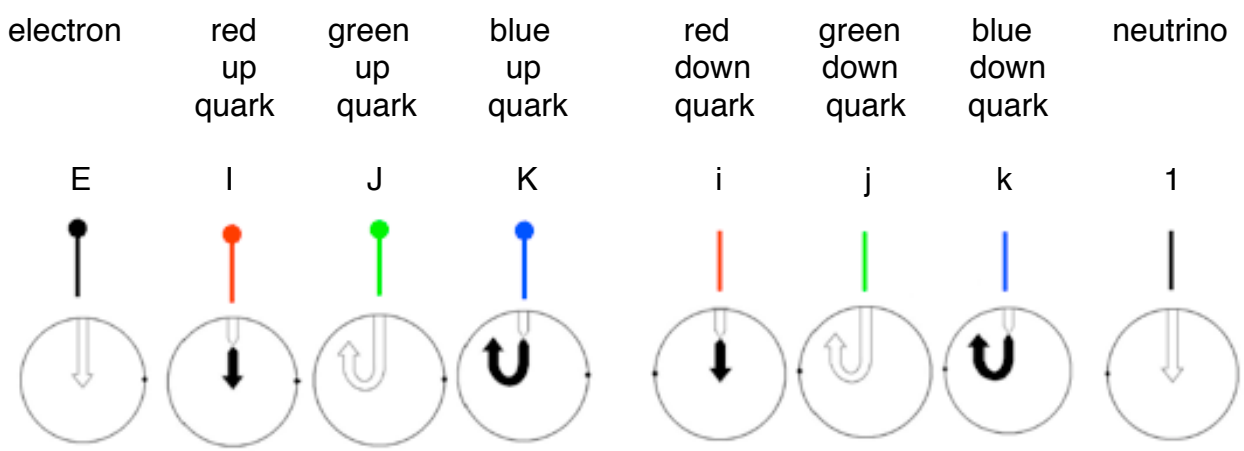
N(octonion) is an octonion number factor relating up-type quark masses to
down-type quark masses in each generation.

Sym is an internal symmetry factor, relating 2nd and 3rd generation massive
leptons to first generation fermions. It is not used in first-generation calculations.

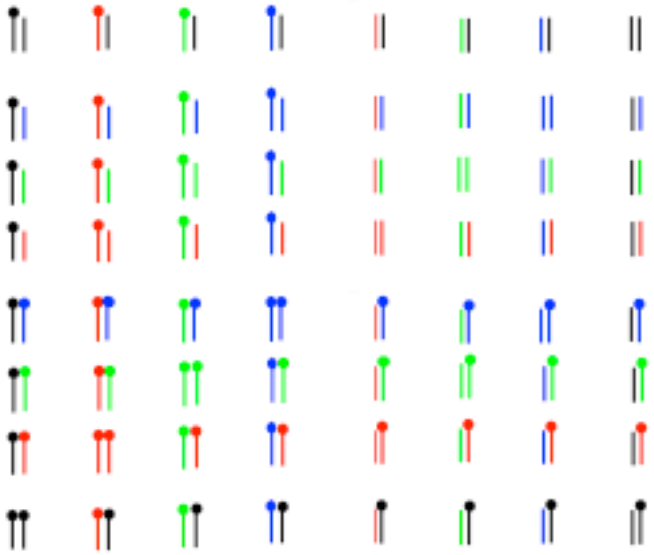
3 Generation Fermion Combinatorics

First Generation (8)

(geometric representation of Octonions is from arXiv 1010.2979)



Second Generation (64)

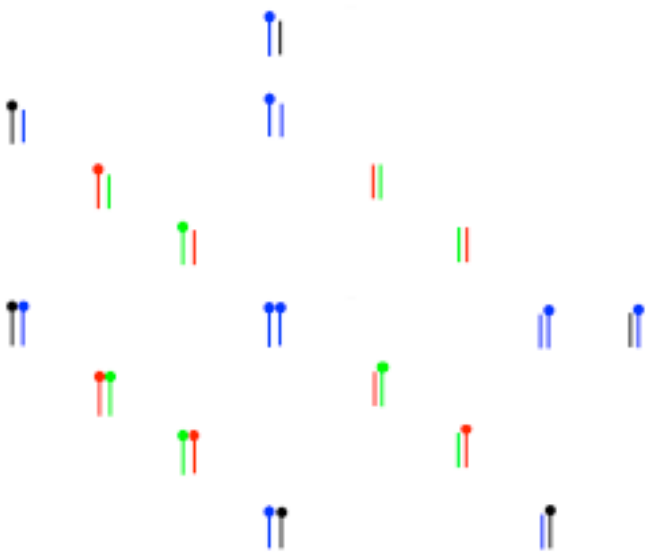


Mu Neutrino (1)
Rule: a Pair belongs to the Mu Neutrino if:
All elements are Colorless (black)
and all elements are Associative
(that is, is 1 which is the only Colorless Associative element) .

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).

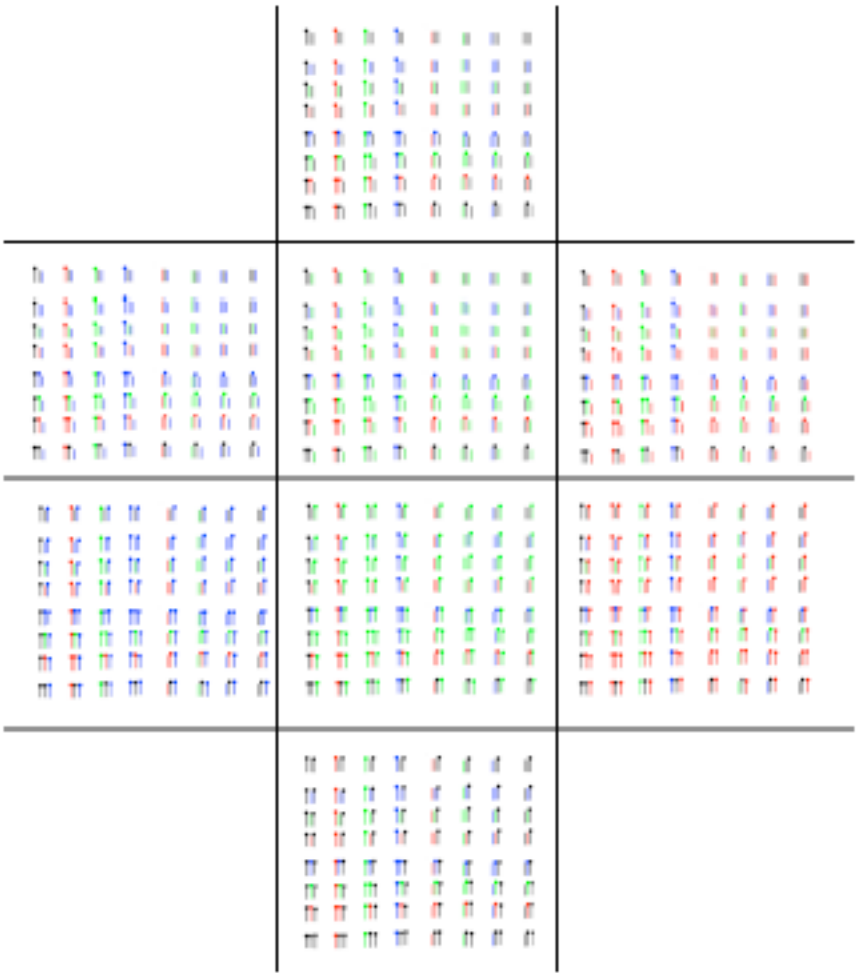
Blue Strange Quark **(3)**
Rule: a Pair belongs to the Blue Strange Quark if:
There is at least one Blue element and the other element is Blue or Colorless (black)
and all elements are Associative (that is, is either 1 or i or j or k).

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)

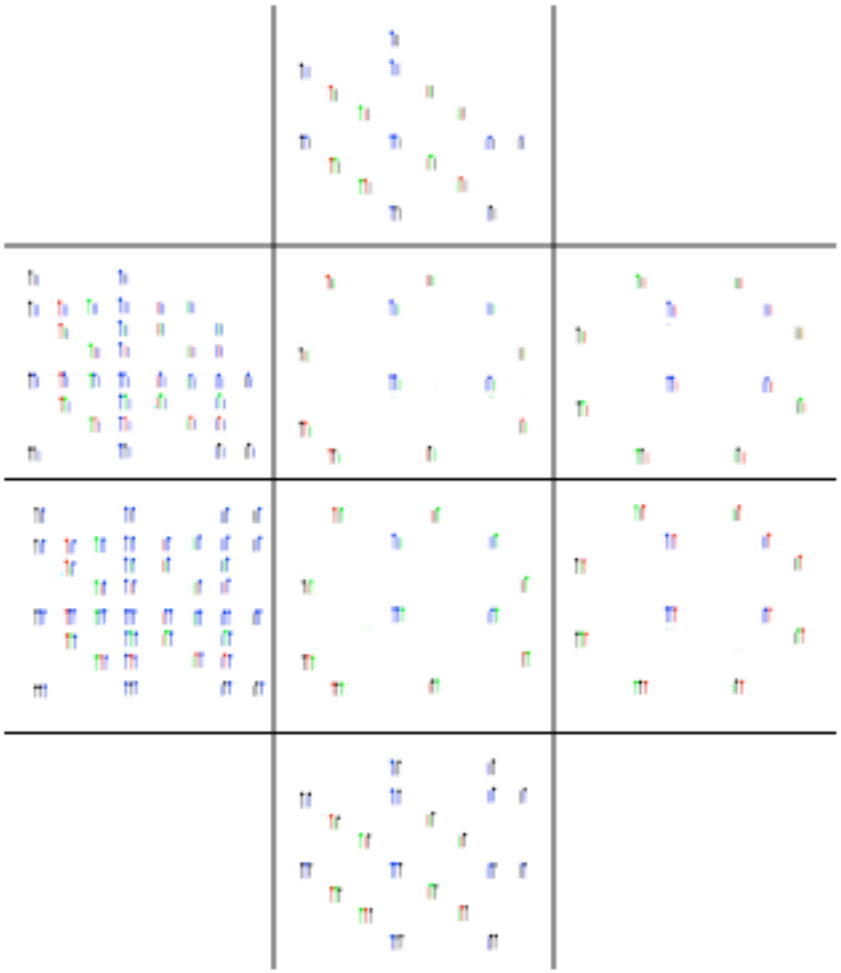


Tau Neutrino (1)
Rule: a Triple belongs to the Tau Neutrino if:
All elements are Colorless (black)
and all elements are Associative
(that is, is 1 which is the only Colorless Associative element)

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)

The first generation down quark constituent mass : electron mass ratio is:

The electron, E, can only be taken into the tree-level-massless neutrino, 1, by photon, weak boson, and gluon interactions.
The electron and neutrino, or their antiparticles, cannot be combined to produce any of the massive up or down quarks.
The neutrino, being massless at tree level, does not add anything to the mass formula for the electron.
Since the electron cannot be related to any other massive Dirac fermion,
its volume V(Qelectron) is taken to be 1.

Next consider a red down quark i.
By gluon interactions, i can be taken into j and k, the blue and green down quarks.
By also using weak boson interactions,
it can also be taken into I, J, and K, the red, blue, and green up quarks.
Given the up and down quarks, pions can be formed from quark-antiquark pairs,
and the pions can decay to produce electrons and neutrinos.
Therefore the red down quark (similarly, any down quark)
is related to all parts of S^7 x RP^1,
the compact manifold corresponding to { 1, i, j, k, E, I, J, K }
and therefore
a down quark should have
a spinor manifold volume factor V(Qdown quark) of the volume of S^7 x RP^1.

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

$$V(\text{Qdown quark}) / V(\text{Qelectron}) = V(S^7 \times RP^1)/1 = \pi^5 / 3.$$

Since the first generation graviton factor is 6,

$$m_d / m_e = 6\, V(S^7 \times RP^1) = 2\pi^5 = 612.03937$$

As the up quarks correspond to I, J, and K, which are the octonion transforms under E of i, j, and k of the down quarks, the up quarks and down quarks have the same constituent mass

$$m_u = m_d.$$

Antiparticles have the same mass as the corresponding particles.
Since the model only gives ratios of masses,
the mass scale is fixed so that the electron mass me = 0.5110 MeV.

Then, the constituent mass of the down quark is md = 312.75 MeV,
and the constituent mass for the up quark is mu = 312.75 MeV.

These results when added up give a total mass of first generation fermion particles:

Sigmaf1 = 1.877 GeV

As the proton mass is taken to be the sum of the constituent masses of its constituent quarks

mproton = mu + mu + md = 938.25 MeV

which is close to the experimental value of 938.27 MeV.

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 }
{ 1, 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 calculated tauon mass of 1.88 GeV is a sum of first generation fermion masses, all of which are valid at the energy level of about 1 GeV.

However, as the tauon mass is about 2 GeV,
the effective tauon mass should be renormalized
from the energy level of 1 GeV at which the mass is 1.88 GeV
to the energy level of 2 GeV.
Such a renormalization should reduce the mass.

If the renormalization reduction were about 5 percent,
the effective tauon mass at 2 GeV would be about 1.78 GeV.
The 1996 Particle Data Group Review of Particle Physics gives a tauon mass of 1.777 GeV.

All triples corresponding to the tau and the tau-neutrino are colorless.

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,
respectively.

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 tauon mass times
the third generation graviton factor 6/2 = 3,
so the red beauty quark mass is mb = 5.63111 GeV.

The blue and green beauty quarks are similarly determined to also be 5.63111 GeV.

The calculated beauty quark mass of 5.63 GeV is a consitituent mass,
that is, it corresponds to the conventional pole mass plus 312.8 MeV.
Therefore, the calculated beauty quark mass of 5.63 GeV
corresponds to a conventional pole mass of 5.32 GeV.

The 1996 Particle Data Group Review of Particle Physics gives
a lattice gauge theory beauty quark pole mass as 5.0 GeV.

The pole mass can be converted to an MSbar mass
if the color force strength constant alpha_s is known.
The conventional value of alpha_s at about 5 GeV is about 0.22.

Using alpha_s (5 GeV) = 0.22, a pole mass of 5.0 GeV
gives an MSbar 1-loop beauty quark mass of 4.6 GeV,
and
an MSbar 1,2-loop beauty quark mass of 4.3, evaluated at about 5 GeV.

If the MSbar mass is run from 5 GeV up to 90 GeV,
the MSbar mass decreases by about 1.3 GeV,
giving an expected MSbar mass of about 3.0 GeV at 90 GeV.

DELPHI at LEP has observed the Beauty Quark
and found a 90 GeV MSbar beauty quark mass of about 2.67 GeV,
with error bars +/- 0.25 (stat) +/- 0.34 (frag) +/- 0.27 (theo).

The theoretical model calculated Beauty Quark mass of 5.63 GeV
corresponds to a pole mass of 5.32 GeV,
which is somewhat higher than the conventional value of 5.0 GeV.

However, the theoretical model calculated value
of the color force strength constant alpha_s at about 5 GeV is about 0.166,
while the conventional value
of the color force strength constant alpha_s at about 5 GeV is about 0.216,
and
the theoretical model calculated value
of the color force strength constant alpha_s at about 90 GeV is about 0.106,
while the conventional value
of the color force strength constant alpha_s at about 90 GeV is about 0.118.

The theoretical model calculations gives a Beauty Quark pole mass (5.3 GeV) that
is about 6 percent higher than the conventional Beauty Quark pole mass (5.0 GeV),
and a color force strength alpha_s at 5 GeV (0.166)
such that 1 + alpha_s = 1.166 is about 4 percent lower
than the conventional value of 1 + alpha_s = 1.216 at 5 GeV.

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 the red truth quark
is 161 / 7 = 23 times the red beauty quark mass,
and the red T-quark mass is
mt = 129.5155 GeV

The blue and green truth quarks are similarly determined to also be 129.5155 GeV.

This is the value of the Low Mass State of the Truth calculated in E8 Physics.
The Middle Mass State of the Truth Quark has been observed by Fermilab since 1994.
The Low and High Mass States of the Truth Quark have, in my opinion, also been observed by Fermilab but the Fermilab and CERN establishments disagree.

All other masses than the electron mass
(which is the basis of the assumption of the value of the Higgs scalar field vacuum expectation value v = 252.514 GeV),
including the Higgs scalar mass and Truth quark mass,
are calculated (not assumed) masses in E8 Physics.
These results when added up give a total mass of third generation fermion particles:

Sigmaf3 = 1,629 GeV

The second generation fermion particles correspond to pairs of octonions.
There are 8^2 = 64 such pairs.

The pair { 1,1 } corresponds to the mu-neutrino.

The pairs { 1, E }, { E, 1 }, and { E, E } correspond to the muon.

For the Sym factor, compare the symmetries of the muon pairs
to the symmetries of the first generation fermion particles:
The pair { E, E } should correspond to the E electron.
The other two muon pairs have a symmetry group S2,
which is 1/3 the size of the color symmetry group S3
which gives the up and down quarks their mass of 312.75 MeV.

Therefore the mass of the muon should be the sum of
the { E, E } electron mass and
the { 1, E }, { E, 1 } symmetry mass, which is 1/3 of the up or down quark mass.
Therefore, mmu = 104.76 MeV .

According to the 1998 Review of Particle Physics of the Particle Data Group,
the experimental muon mass is about 105.66 MeV which may be consistent with
radiative corrections for the calculated tree-level mmu = 104.76 MeV as
Bailin and Love, in “Introduction to Gauge Field Theory”, IOP (rev ed 1993), say:
"... considering the order alpha radiative corrections to muon decay ... Numerical details are contained in Sirlin ... 1980 Phys. Rev. D 22 971 ... who concludes that the order alpha corrections have the effect of increasing the decay rate about 7% compared with the tree graph prediction ...". Since the decay rate is proportional to mmu^5 the corresponding effective increase in muon mass would be about 1.36%, which would bring 104.8 MeV up to about 106.2 MeV.

All pairs corresponding to the muon and the mu-neutrino are colorless.

The red, blue and green strange quark each corresponds
to the 3 pairs involving 1 and i, j, or k.

The red strange quark is defined as the three pairs { 1, i }, { i, 1 }, { i, i }
because i is the red down quark.
Its mass should be the sum of two parts:
the { i, i } red down quark mass, 312.75 MeV, and
the product of the symmetry part of the muon mass, 104.25 MeV,
times the graviton factor.

Unlike the first generation situation,
massive second and third generation leptons can be taken,
by both of the colorless gravitons that may carry electric charge,
into massive particles.

Therefore the graviton factor for the second and third generations is 6/2 = 3.

So the symmetry part of the muon mass times the graviton factor 3 is 312.75 MeV, and
the red strange quark constituent mass is ms = 312.75 MeV + 312.75 MeV = 625.5 MeV

The blue strange quarks correspond to the three pairs involving j,
the green strange quarks correspond to the three pairs involving k,
and their masses are similarly determined to also be 625.5 MeV.
The charm quark corresponds to the remaining 64 - 1 - 3 - 9 = 51 pairs.

Therefore, the mass of the red charm quark should be the sum of two parts:
the { i, i }, red up quark mass, 312.75 MeV;
and
the product of the symmetry part of the strange quark mass, 312.75 MeV,
and the charm to strange octonion number factor 51 / 9,
which product is 1,772.25 MeV.

Therefore the red charm quark constituent mass is
mc = 312.75 MeV + 1,772.25 MeV = 2.085 GeV

The blue and green charm quarks are similarly determined to also be 2.085 GeV.

The calculated Charm Quark mass of 2.09 GeV is a consitituent mass,
that is, it corresponds to the conventional pole mass plus 312.8 MeV.

Therefore, the calculated Charm Quark mass of 2.09 GeV corresponds to a
conventional pole mass of 1.78 GeV.

The 1996 Particle Data Group Review of Particle Physics gives a range for the
Charm Quark pole mass from 1.2 to 1.9 GeV.

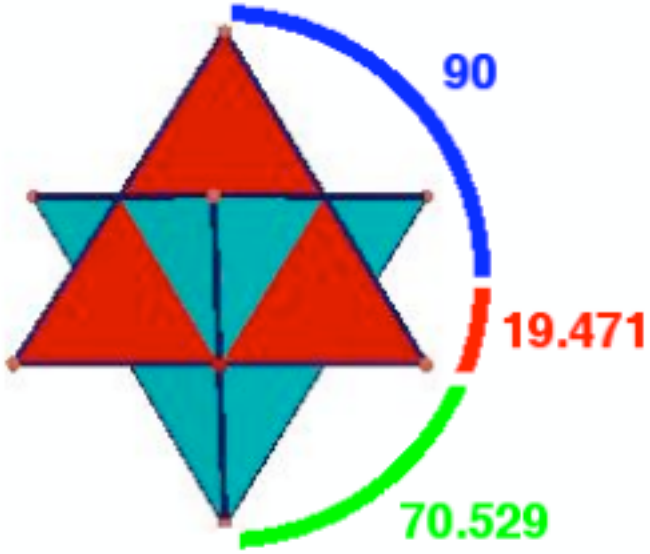
The pole mass can be converted to an MSbar mass if the color force strength constant alpha_s is known.
The conventional value of alpha_s at about 2 GeV is about 0.39,
which is somewhat lower than the theoretical model value.
Using alpha_s (2 GeV) = 0.39, a pole mass of 1.9 GeV
gives an MSbar 1-loop mass of 1.6 GeV, evaluated at about 2 GeV.

These results when added up give a total mass of second generation fermion particles:

Sigmaf2 = 32.9 GeV

Kobayashi-Maskawa Parameters

In E8 Physics the KM Unitarity Triangle angles can be seen on the Stella Octangula



The Kobayashi-Maskawa parameters are determined in terms of
the sum of the masses of the 30 first-generation fermion particles and antiparticles,
denoted by

Smf1 = 7.508 GeV,

and the similar sums for second-generation and third-generation fermions,
denoted by

Smf2 = 32.94504 GeV and Smf3 = 1,629.2675 GeV.

The resulting KM matrix is:

	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

Below the energy level of ElectroWeak Symmetry Breaking
the Higgs mechanism gives mass to particles.

According to a Review on the Kobayashi-Maskawa mixing matrix by Ceccucci, Ligeti, and Sakai in the 2010 Review of Particle Physics (note that I have changed their terminology of CKM matrix to the KM terminology that I prefer because I feel that it was Kobayashi and Maskawa, not Cabibbo, who saw that 3x3 was the proper matrix structure): "... the charged-current W± interactions couple to the ... quarks with couplings given by ...

Vud	Vus	Vub
Vcd	Vcs	Vcb
Vtd	Vts	Vtb

This Kobayashi-Maskawa (KM) matrix is a 3x3 unitary matrix.
It can be parameterized by three mixing angles and the CP-violating KM phase ...
The most commonly used unitarity triangle arises from
Vud Vub∗ + Vcd Vcb∗ + Vtd Vtb∗ = 0,
by dividing each side by the best-known one, Vcd Vcb∗
...
$\bar{\rho} + i\bar{\eta} = -(V_{ud} V_{ub}^*)/(V_{cd} V_{cb}^*)$ is phase-convention- independent ...

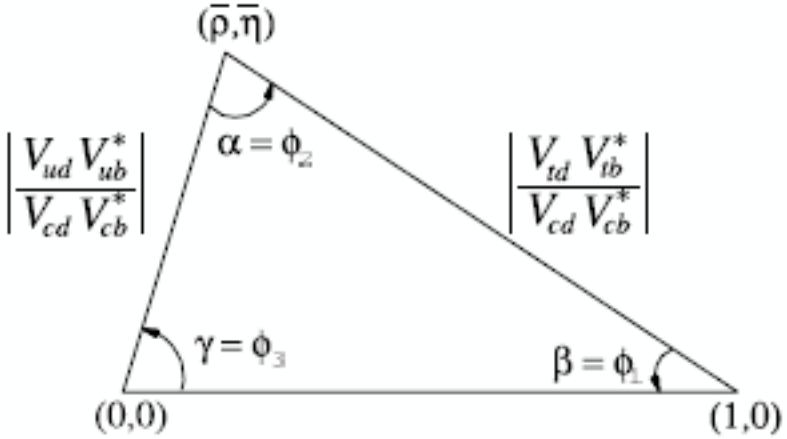


Figure 11.1: Sketch of the unitarity triangle.

... sin 2β = 0.673 ± 0.023 ... α = 89.0 +4.4 –4.2 degrees ... γ = 73 +22 –25 degrees ...
The sum of the three angles of the unitarity triangle, α + β + γ = (183 +22 –25) degrees,
is ... consistent with the SM expectation. ...

The area... of ...[the]... triangle...[is]... half of the Jarlskog invariant, J,
which is a phase-convention-independent measure of CP violation,
defined by Im Vij Vkl Vil∗ Vkj∗ = J SUM(m,n) ε_ikm ε_jln

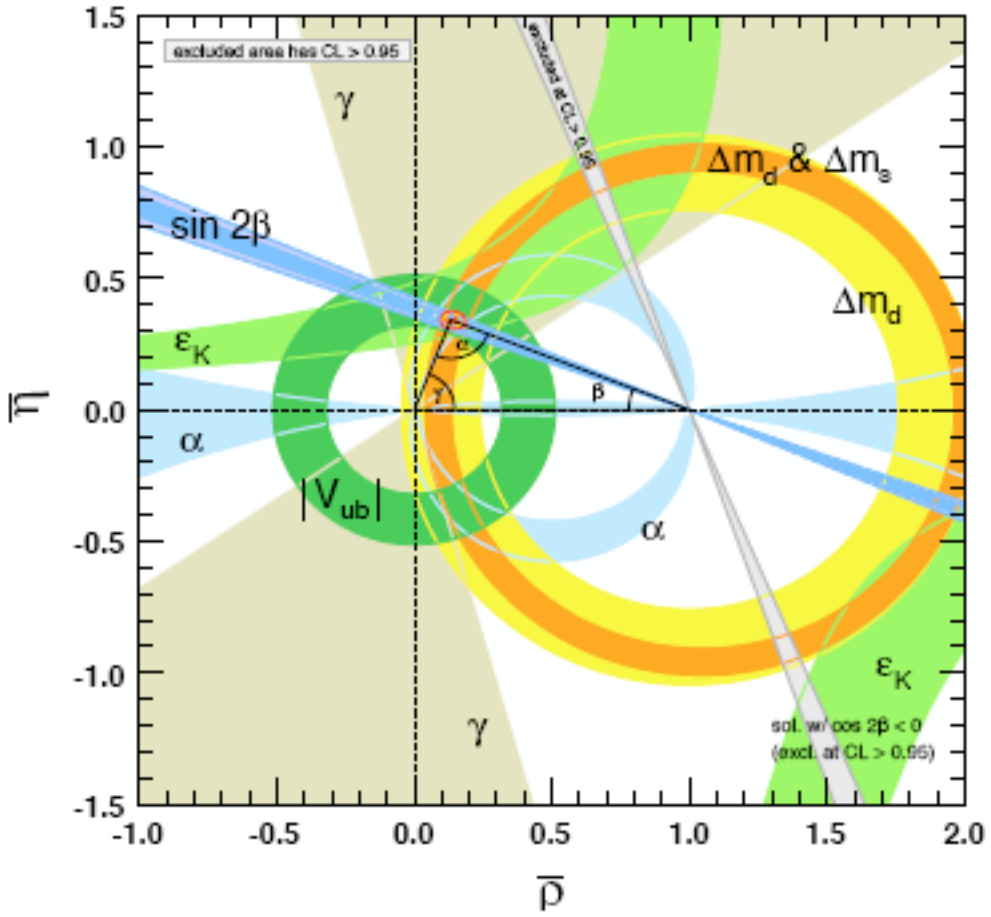


Figure 11.2: Constraints on the $\bar{\rho}, \bar{\eta}$ plane. The shaded areas have 95% CL.

The fit results for the magnitudes of all nine KM elements are ...

0.97428 ± 0.00015	0.2253 ± 0.0007	0.00347 +0.00016 –0.00012
0.2252 ± 0.0007	0.97345 +0.00015 –0.00016	0.0410 +0.0011 –0.0007
0.00862 +0.00026 –0.00020	0.0403 +0.0011–0.0007	0.999152 +0.000030–0.000045

and the Jarlskog invariant is J = (2.91 +0.19-0.11)x10–5. ...".

Above the energy level of ElectroWeak Symmetry Breaking
particles are massless.

Kea (Marni Sheppeard) proposed
that in the Massless Realm the mixing matrix might be democratic.
In Z. Phys. C - Particles and Fields 45, 39-41 (1989) Koide said: "...
the mass matrix ... MD ... of the type ... 1/3 x m x

1 1 1
1 1 1
1 1 1

... has name... "democratic" family mixing ...
the ... democratic ... mass matrix can be diagonalized by the transformation matrix A ...

1/sqrt(2) -1/sqrt(2) 0
1/sqrt(6) 1/sqrt(6) -2/sqrt(6)
1/sqrt(3) 1/sqrt(3) 1/sqrt(3)

as A MD At =

0 0 0
0 0 0
0 0 m

...".

Up in the Massless Realm you might just say that there is no mass matrix,
just a democratic mixing matrix of the form 1/3 x

1 1 1
1 1 1
1 1 1

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

When go down to our Massive Realm by ElectroWeak Symmetry Breaking
then you might as a first approximation use m = 1
so that all the mass first goes to the third generation as

0 0 0
0 0 0
0 0 1

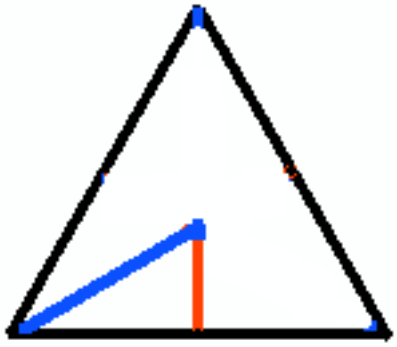
which is physically like the Higgs being a T-Tbar quark condensate.

Consider a 3-dim Euclidean space of generations:

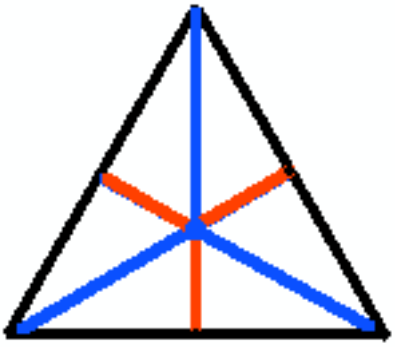
The case of mass only going to one generation
can be represented as a line or 1-dimensional simplex

in which the blue mass-line covers the entire black simplex line.

If mass only goes to one other generation
that can be represented by a red line extending to a second dimension
forming a small blue-red-black triangle

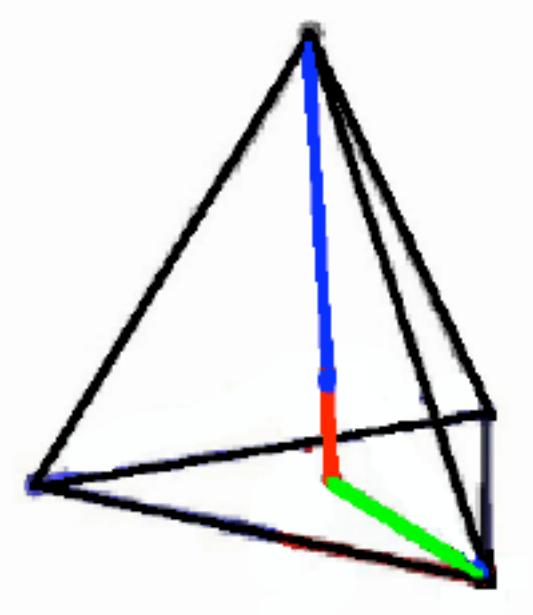


that can be extended by reflection to form six small triangles making up a large triangle

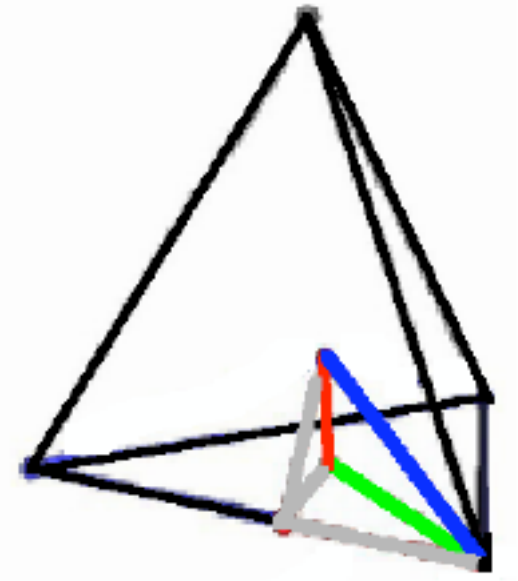


Each of the six component triangles has 30-60-90 angle structure:

If mass goes on further to all three generations
that can be represented by a green line extending to a third dimension



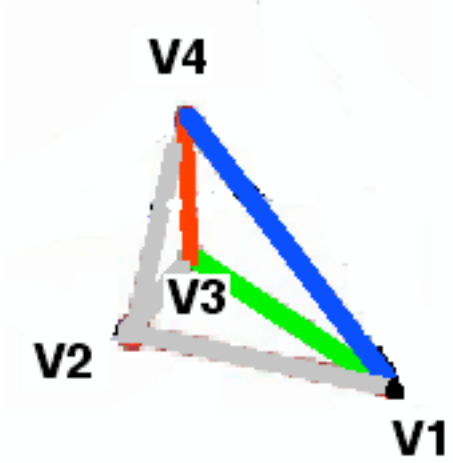
If you move the blue line from the top vertex to join the green vertex



you get a small blue-red-green-gray-gray-gray tetrahedron
that can be extended by reflection to form 24 small tetrahedra
making up a large tetrahedron.

Reflection among the 24 small tetrahedra corresponds
to the 12+12 = 24 elements of the Binary Tetrahedral Group.

The basic blue-red-green triangle of the basic small tetrahedron



has the angle structure of the K-M Unitary Triangle.

Using data from R. W. Gray's "Encyclopedia Polyhedra: A Quantum Module"
with lengths

V1.V2 = (1/2) EL ≡ Half of the regular Tetrahedron's edge length.
V1.V3 = (1 / sqrt(3)) EL ≅ 0.577 350 269 EL
V1.V4 = 3 / (2 sqrt(6)) EL ≅ 0.612 372 436 EL
V2.V3 = 1 / (2 sqrt(3)) EL ≅ 0.288 675 135 EL
V2.V4 = 1 / (2 sqrt(2)) EL ≅ 0.353 553 391 EL
V3.V4 = 1 / (2 sqrt(6)) EL ≅ 0.204 124 145 EL

the Unitarity Triangle angles are:

β = V3.V1.V4 = arccos(2 sqrt(2) / 3) ≅ 19.471 220 634 degrees so sin 2β = 0.6285

α = V1.V3.V4 = 90 degrees

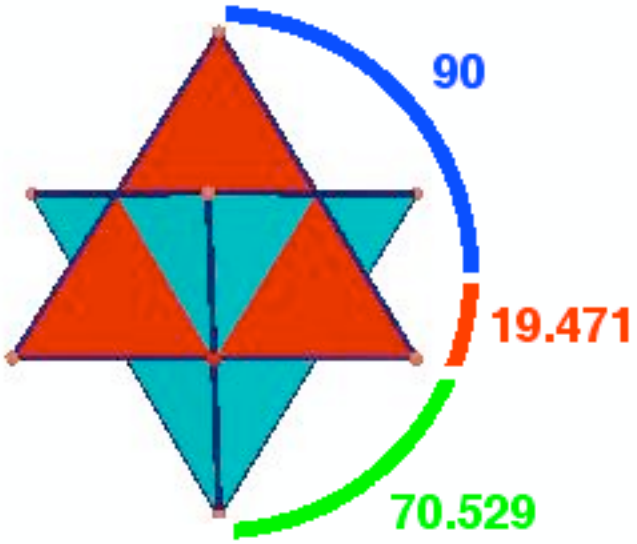
γ = V1.V4.V3 = arcsin(2 sqrt(2) / 3) ≅ 70.528 779 366 degrees

which is substantially consistent with the 2010 Review of Particle Properties

sin 2β = 0.673 ± 0.023 so β = 21.1495 degrees
α = 89.0 +4.4 –4.2 degrees
γ = 73 +22 –25 degrees

and so also consistent with the Standard Model expectation.

The constructed Unitarity Triangle angles can be seen on the Stella Octangula configuration of two dual tetrahedra (image from gauss.math.nthu.edu.tw):



In the Cl(1,25) E8 model the Kobayashi-Maskawa parameters are determined in terms of
the sum of the masses of the 30 first-generation fermion particles and antiparticles, denoted by
Smf1 = 7.508 GeV,

and the similar sums for second-generation and third-generation fermions, denoted
by Smf2 = 32.94504 GeV and Smf3 = 1,629.2675 GeV.

The reason for using sums of all fermion masses (rather than sums of quark masses only) is that all fermions are in the same spinor representation of Spin(8),
and the Spin(8) representations are considered to be fundamental.

The following formulas use the above masses
to calculate Kobayashi-Maskawa parameters:

phase angle d13 = gamma = 70.529 degrees

sin(theta12) = s12 = [me+3md+3mu]/sqrt([me^2+3md^2+3mu^2]+
+ [mmu^2+3ms^2+3mc^2]) = 0.222198

sin(theta13) = s13 = [me+3md+3mu]/sqrt([me^2+3md^2+3mu^2]+
+ [mtau^2+3mb^2+3mt^2]) = 0.004608

sin(*theta23 = [mmu+3ms+3mc]/sqrt([mtau^2+3mb^2+3mt^2]+
+ [mmu^2+3ms^2+3mc^2])

sin(theta23) = s23 = sin(*theta23) sqrt(Sigmaf2 / Sigmaf1) = 0.04234886

The factor sqrt(Smf2 /Smf1) appears in s23 because an s23 transition is to the second generation and not all the way to the first generation, so that the end product of an s23 transition has a greater available energy than s12 or s13 transitions by a factor of Smf2 / Smf1 .

Since the width of a transition is proportional to the square of the modulus of the relevant KM entry and the width of an s23 transition has greater available energy than the s12 or s13 transitions by a factor of Smf2 / Smf1
the effective magnitude of the s23 terms in the KM entries is increased by the factor sqrt(Smf2 /Smf1) .

The Chau-Keung parameterization is used, as it allows the K-M matrix to be represented as the product of the following three 3x3 matrices:

1	0	0
0	cos(theta23)	sin(theta23)
0	-sin(theta23)	cos(theta23)

cos(theta13)	0	sin(theta13)exp(-i d13)
0	1	0
-sin(theta13)exp(i d13)	0	cos(theta13)

cos(theta12)	sin(theta12)	0
-sin(theta12)	cos(theta12)	0
0	0	1

The resulting Kobayashi-Maskawa parameters
for W+ and W- charged weak boson processes, are:

	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

The matrix is labelled by either (u c t) input and (d s b) output,
or, as above, (d s b) input and (u c t) output.

For Z0 neutral weak boson processes, which are suppressed by the GIM
mechanism of cancellation of virtual subprocesses, the matrix is labelled by either
(u c t) input and (u'c't') output, or, as below, (d s b) input and (d's'b') output:

	d	s	b
d'	0.975	0.222	0.00249 -0.00388i
s'	-0.222 -0.000161i	0.974 -0.0000365i	0.0423
b'	0.00698 -0.00378i	-0.0418 -0.00086i	0.999

Since neutrinos of all three generations are massless at tree level,
the lepton sector has no tree-level K-M mixing.

In hep-ph/0208080, Yosef Nir says: "... Within the Standard Model,
the only source of CP violation is the Kobayashi-Maskawa (KM) phase ...
The study of CP violation is, at last, experiment driven. ...
The CKM matrix provides a consistent picture
of all the measured flavor and CP violating processes. ...
There is no signal of new flavor physics. ...
Very likely,
the KM mechanism is the dominant source of CP violation in flavor changing processes.
... The result is consistent with the SM predictions. ...".

Neutrino Masses Beyond Tree Level

Consider the three generations of neutrinos:
nu_e (electron neutrino); nu_m (muon neutrino); nu_t
and three neutrino mass states: nu_1 ; nu_2 : nu_3
and
the division of 8-dimensional spacetime into
4-dimensional physical Minkowski spacetime
plus
4-dimensional CP2 internal symmetry space.

The heaviest mass state nu_3 corresponds to a neutrino
whose propagation begins and ends in CP2 internal symmetry
space,lying entirely therein. According to the Cl(1,25) E8 model
the mass of nu_3 is zero at tree-level
but it picks up a first-order correction
propagating entirely through internal symmetry space by merging
with an electron through the weak and electromagnetic forces,
effectively acting not merely as a point
but
as a point plus an electron loop at beginning and ending points
so
the first-order corrected mass of nu_3 is given by
M_nu_3 x (1/sqrt(2)) = M_e x GW(mproton^2) x alpha_E
where the factor (1/sqrt(2)) comes from the Ut3 component
of the neutrino mixing matrix
so that

M_nu_3 = sqrt(2) x M_e x GW(mproton^2) x alpha_E =
= 1.4 x 5 x 10^5 x 1.05 x 10^(-5) x (1/137) eV =
= 7.35 / 137 = 5.4 x 10^(-2) eV.

The neutrino-plus-electron loop can be anchored by weak force
action through any of the 6 first-generation quarks
at each of the beginning and ending points, and that the
anchor quark at the beginning point can be different from
the anchor quark at the ending point,
so that there are 6x6 = 36 different possible anchorings.

The intermediate mass state nu_2 corresponds to a neutrino
whose propagation begins or ends in CP2 internal symmetry space
and ends or begins in M4 physical Minkowski spacetime,
thus having only one point (either beginning or ending) lying
in CP2 internal symmetry space where it can act not merely
as a point but as a point plus an electron loop.

According to the Cl(1,25) E8 model the mass of nu_2 is zero at
tree-level but it picks up a first-order correction at only one
(but not both) of the beginning or ending points
so that so that there are 6 different possible anchorings
for nu_2 first-order corrections, as opposed to the 36 different
possible anchorings for nu_3 first-order corrections,
so that
the first-order corrected mass of nu_2 is less than
the first-order corrected mass of nu_3 by a factor of 6,
so

the first-order corrected mass of nu_2 is
M_nu_2 = M_nu_3 / Vol(CP2) = 5.4 x 10^(-2) / 6
= 9 x 10^(-3)eV.

The low mass state nu_1 corresponds to a neutrino
whose propagation begins and ends in physical Minkowski
spacetime.
thus having only one anchoring to CP2 interna symmetry space.

According to the Cl(1,25) E8 model the mass of nu_1 is zero at
tree-level but it has only 1 possible anchoring to CP2
as opposed to the 36 different possible anchorings for nu_3
first-order corrections
or the 6 different possible anchorings for nu_2 first-order
corrections
so that
the first-order corrected mass of nu_1 is less than
the first-order corrected mass of nu_2 by a factor of 6,
so

the first-order corrected mass of nu_1 is
M_nu_1 = M_nu_2 / Vol(CP2) = 9 x 10^(-3) / 6
= 1.5 x 10^(-3)eV.

Therefore:

the mass-squared difference D(M23^2) = M_nu_3^2 - M_nu_2^2 =
= (2916 - 81) x 10^(-6) eV^2 =
= 2.8 x 10^(-3) eV^2

and

the mass-squared difference D(M12^2) = M_nu_2^2 - M_nu_1^2 =
= (81 - 2) x 10^(-6) eV^2 =
= 7.9 x 10^(-5) eV^2

The 3x3 unitary neutrino mixing matrix neutrino mixing matrix U

	nu_1	nu_2	nu_3
nu_e	Ue1	Ue2	Ue3
nu_m	Um1	Um2	Um3
nu_t	Ut1	Ut2	Ut3

can be parameterized (based on the 2010 Particle Data Book)
by 3 angles and 1 Dirac CP violation phase

$$U = \begin{pmatrix} c_{12}\,c_{13} & s_{12}\,c_{13} & s_{13}\,e^{-i\delta} \\ -s_{12}\,c_{23} - c_{12}\,s_{23}\,s_{13}\,e^{i\delta} & c_{12}\,c_{23} - s_{12}\,s_{23}\,s_{13}\,e^{i\delta} & s_{23}\,c_{13} \\ s_{12}\,s_{23} - c_{12}\,c_{23}\,s_{13}\,e^{i\delta} & -c_{12}\,s_{23} - s_{12}\,c_{23}\,s_{13}\,e^{i\delta} & c_{23}\,c_{13} \end{pmatrix}$$

where cij = cos(theta_ij) , sij = sin(theta_ij)

The angles are

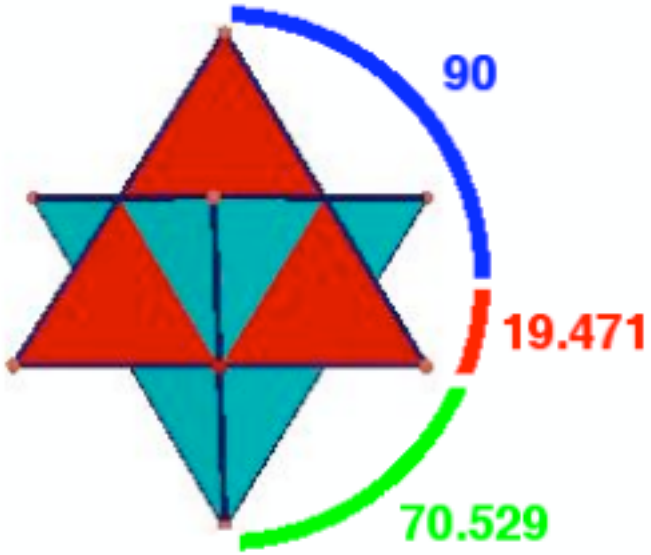
theta_23 = pi/4 = 45 degrees
because
nu_3 has equal components of nu_m and nu_t so
that Um3 = Ut3 = 1/sqrt(2) or, in conventional
notation, mixing angle theta_23 = pi/4
so that cos(theta_23) = 0.707 = sqrt(2)/2 = sin(theta_23)

theta_13 = 9.594 degrees = asin(1/6)
and cos(theta_13) = 0.986
because sin(theta_13) = 1/6 = 0.167 = |Ue3| = fraction of nu_3 that is nu_e

theta_12 = pi/6 = 30 degrees
because
sin(theta_12) = 0.5 = 1/2 = Ue2 = fraction of nu_2 begin/end points
that are in the physical spacetime where massless nu_e lives
so that cos(theta_12) = 0.866 = sqrt(3)/2

d = 70.529 degrees is the Dirac CP violation phase
ei(70.529) = cos(70.529) + i sin(70.529) = 0.333 + 0.943 i
This is because the neutrino mixing matrix has 3-generation structure
and so has the same phase structure as the KM quark mixing matrix
in which the Unitarity Triangle angles are:
β = V3.V1.V4 = arccos(2 sqrt(2) / 3) ≅ 19.471 220 634 degrees so sin 2β = 0.6285
α = V1.V3.V4 = 90 degrees
γ = V1.V4.V3 = arcsin(2 sqrt(2) / 3) ≅ 70.528 779 366 degrees

The constructed Unitarity Triangle angles can be seen on the Stella Octangula configuration of two dual tetrahedra (image from gauss.math.nthu.edu.tw):



Then we have for the neutrino mixing matrix:

	nu_1	nu_2	nu_3
nu_e	0.866 x 0.986	0.50 x 0.986	0.167 x e-id
nu_m	-0.5 x 0.707 -0.866 x 0.707 x 0.167 x eid	0.866 x 0.707 -0.5 x 0.707 x 0.167 x eid	0.707 x 0.986
nu_t	0.5 x 0.707 -0.866 x 0.707 x 0.167 x eid	-0.866 x 0.707 -0.5 x 0.707 x 0.167 x eid	0.707 x 0.986

	nu_1	nu_2	nu_3
nu_e	0.853	0.493	0.167 e-id
nu_m	-0.354 -0.102 eid	0.612 -0.059 eid	0.697
nu_t	0.354 -0.102 eid	-0.612 -0.059 eid	0.697

Since ei(70.529) = cos(70.529) + i sin(70.529) = 0.333 + 0.943 i
and .333e-i(70.529) = cos(70.529) - i sin(70.529) = 0.333 - 0.943 i

	nu_1	nu_2	nu_3
nu_e	0.853	0.493	0.056 - 0.157 i
nu_m	-0.354 -0.034 - 0.096 i	0.612 -0.020 - 0.056 i	0.697
nu_t	0.354 -0.034 - 0.096 i	-0.612 -0.020 - 0.056 i	0.697

for a result of

	nu_1	nu_2	nu_3
nu_e	0.853	0.493	0.056 - 0.157 i
nu_m	-0.388 - 0.096 i	0.592 - 0.056 i	0.697
nu_t	0.320 - 0.096 i	0.632 - 0.056 i	0.697

which is consistent with the approximate experimental values of mixing angles
shown in the Michaelmas Term 2010 Particle Physics handout
of Prof Mark Thomson if the matrix is modified by taking into account
the March 2012 results from Daya Bay
observing non-zero theta_13 = 9.54 degrees.

Proton-Neutron Mass Difference

An up valence quark, constituent mass 313 Mev,
does not often swap places with a 2.09 Gev charm sea quark,
but
a 313 Mev down valence quark
can more often swap places with a 625 Mev strange sea quark.

Therefore the Quantum color force
constituent mass of the down valence quark is heavier by about

(ms - md) (md/ms)^2 a(w) |Vds| = 312 x 0.25 x 0.253 x 0.22 Mev = 4.3 Mev,

(where a(w) = 0.253 is the geometric part of the weak force strength
and |Vds| = 0.22 is the magnitude
of the K-M parameter mixing first generation down and second generation strange)

so that the Quantum color force constituent mass Qmd of the down quark is

$$Qmd = 312.75 + 4.3 = 317.05 \text{ MeV}.$$

Similarly, the up quark Quantum color force mass increase is about

(mc - mu) (mu/mc)^2 a(w) |V(uc)| = 1777 x 0.022 x 0.253 x 0.22 Mev = 2.2 Mev,

(where |Vuc| = 0.22 is the magnitude
of the K-M parameter mixing first generation up and second generation charm)

so that the Quantum color force constituent mass Qmu of the up quark is

$$Qmu = 312.75 + 2.2 = 314.95 \text{ MeV}.$$

Therefore, the Quantum color force Neutron-Proton mass difference is

mN - mP = Qmd - Qmu = 317.05 Mev - 314.95 Mev = 2.1 Mev.

Since the electromagnetic Neutron-Proton mass difference is roughly

$$mN - mP = -1 \text{ MeV}$$

the total theoretical Neutron-Proton mass difference is

$$mN - mP = 2.1 \text{ Mev} - 1 \text{ Mev} = 1.1 \text{ Mev},$$

an estimate that is comparable to the experimental value of 1.3 Mev.

Pion as Sine-Gordon Breather

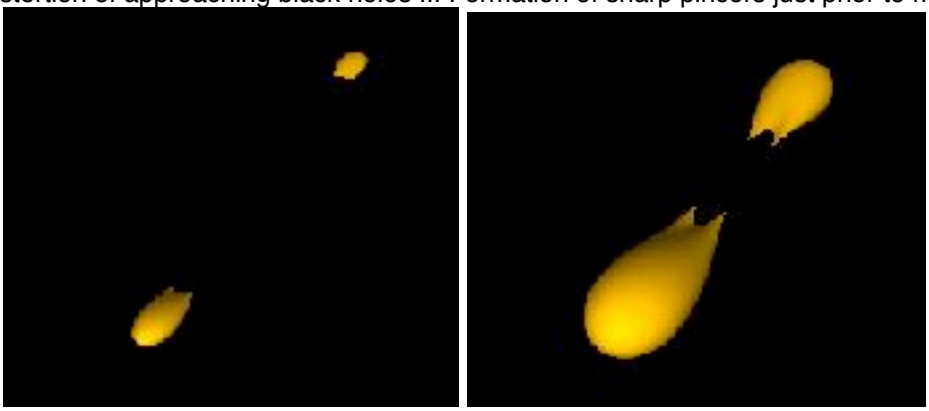
The quark content of a charged pion is a quark - antiquark pair: either Up plus antiDown or Down plus antiUp. Experimentally, its mass is about 139.57 MeV.

The quark is a Schwinger Source Kerr-Newman Black Hole
with constituent mass M 312 MeV.

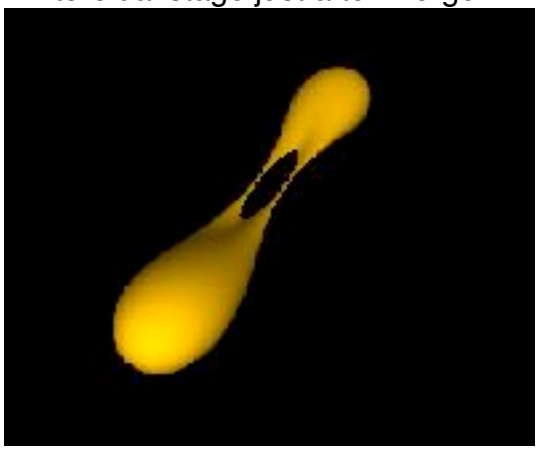
The antiquark is also a Schwinger Source Kerr-Newman Black Hole,
with constituent mass M 312 MeV.

According to section 3.6 of Jeffrey Winicour's 2001 Living Review of the Development of Numerical Evolution Codes for General Relativity (see also a 2005 update):
"... The black hole event horizon associated with ... slightly broken ... degeneracy [of the axisymmetric configuration]... reveals new features not seen in the degenerate case of the head-on collision ... If the degeneracy is slightly broken, the individual black holes form with spherical topology but as they approach, tidal distortion produces two sharp pincers on each black hole just prior to merger. ...

Tidal distortion of approaching black holes ... Formation of sharp pincers just prior to merger ..



... toroidal stage just after merger ...



At merger, the two pincers join to form a single ... toroidal black hole.

The inner hole of the torus subsequently [begins to] close... up (superluminally) ... [If the closing proceeds to completion, it]... produce[s] first a peanut shaped black hole and finally a spherical black hole. ...".

In the physical case of quark and antiquark forming a pion,
the toroidal black hole remains a torus.
The torus is an event horizon and therefore is not a 2-spacelike dimensional torus, but is a (1+1)-dimensional torus with a timelike dimension.

The effect is described in detail in Robert Wald's book General Relativity (Chicago 1984). It can be said to be due to extreme frame dragging, or to timelike translations becoming spacelike as though they had been Wick rotated in Complex SpaceTime.

As Hawking and Ellis say in The LargeScale Structure of Space-Time (Cambridge 1973):
"... The surface r = r+ is ... the event horizon ... and is a null surface ...

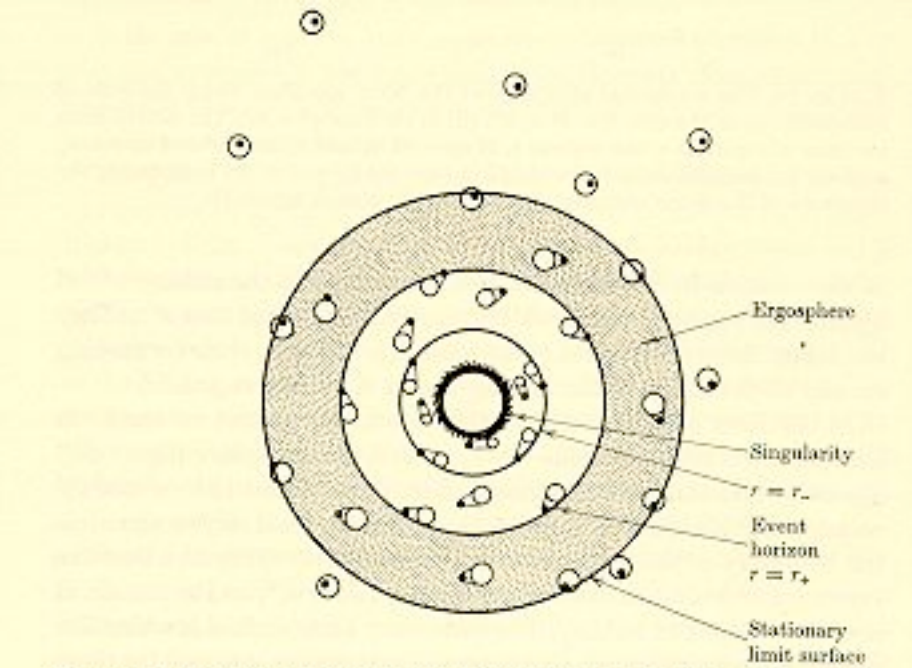


FIGURE 30. The equatorial plane of a Kerr solution with $m^2 > a^2$. The circles represent the position a short time later of flashes of light emitted by the points represented by heavy dots.

... On the surface r = r+ .... the wavefront corresponding to a point on this surface lies entirely within the surface. ...".

A (1+1)-dimensional torus with a timelike dimension can carry a Sine-Gordon Breather.
The soliton and antisoliton of a Sine-Gordon Breather correspond
to the quark and antiquark that make up the pion,
analagous to the Massive Thirring Model.

Sine-Gordon Breathers are described by Sidney Coleman in his Erica lecture paper
Classical Lumps and their Quantum Descendants (1975), reprinted in his book Aspects
of Symmetry (Cambridge 1985),
where he writes the Lagrangian for the Sine-Gordon equation as (Coleman's eq. 4.3):

$$L = (1 / B^2) ((1/2) (df)^2 + A (\cos(f) - 1))$$

Coleman says: “... We see that, in classical physics, B is an irrelevant parameter:
if we can solve the sine-Gordon equation for any non-zero B,
we can solve it for any other B.
The only effect of changing B is the trivial one of changing the energy and momentum
assigned to a given solution of the equation. This is not true in quantum physics,
because the relevant object for quantum physics is not L but [eq. 4.4]

$$L / hbar = (1 / (B^2 hbar)) ((1/2) (df)^2 + A (\cos(f) - 1))$$

An other way of saying the same thing is to say that in quantum physics we have one
more dimensional constant of nature, Planck's constant, than in classical physics. ...
the classical limit, vanishing hbar, is exactly the same as the small-coupling limit,
vanishing B ... from now on I will ... set hbar equal to one. ...
... the sine-Gordon equation ...[has]... an exact periodic solution ...[eq. 4.59]...

$$f(x, t) = (4 / B) \arctan((n \sin(w t) / \cosh(n w x))$$

where [eq. 4.60] $n = sqrt(A - w^2) / w$ and w ranges from 0 to A.
This solution has a simple physical interpretation ... a soliton far to the left ...[and]...
an antisoliton far to the right. As sin(w t) increases, the soliton and antisoliton move
farther apart from each other. When sin(w t) passes through one,
they turn around and begin to approach one another. As sin(w t) comes down to
zero ... the soliton and antisoliton are on top of each other ...
when sin(w t) becomes negative .. the soliton and antisoliton have passed each other.

... Thus, Eq. (4.59) can be thought of as a soliton and an antisoliton oscillation about
their common center-of-mass. For this reason, it is called 'the doublet [or Breather]
solution'. ... the energy of the doublet ...[eq. 4.64]

$$E = 2 M sqrt(1 - (w^2 / A))$$

where [eq. 4.65] $M = 8 sqrt(A) / B^2$ is the soliton mass.

Note that the mass of the doublet is always less than twice the soliton mass,
as we would expect from a soliton-antisoliton pair. ...

Dashen, Hasslacher, and Neveu ... Phys. Rev. D10, 4114; 4130; 4138 (1974).
...[found that]... there is only a single series of bound states, labeled by the integer N ...
The energies ... are ... [eq. 4.82]

$$E_N = 2 M \sin(B'^2 N / 16)$$

where N = 0, 1, 2 ... < 8 pi / B'^2 , [eq. 4.83]
B'^2 = B^2 / (1 - (B^2 / 8 pi)) and M is the soliton mass.
M is not given by Eq. (4.65), but is the soliton mass corrected by the DHN formula,
or, equivalently, by the first-order weak coupling expansion. ...
I have written the equation in this form .. to eliminate A,
and thus avoid worries about renormalization conventions.
Note that the DHN formula is identical to the Bohr-Sommerfeld formula,
except that B is replaced by B'. ...
Bohr and Sommerfeld['s] ... quantization formula says that if we have a one-parameter
family of periodic motions, labeled by the period, T,
then an energy eigenstate occurs whenever [eq. 4.66]

$$[\text{Integral from 0 to T}](dt\ p\ \dot{q} = 2 \pi N,$$

where N is an integer. ... Eq.(4.66) is cruder than the WKB formula,
but it is much more general;
it is always the leading approximation for any dynamical system ...
Dashen et al speculate that Eq. (4.82) is exact. ...
the sine-Gordon equation is equivalent ... to the massive Thirring model.
This is surprising,
because the massive Thirring model is a canonical field theory
whose Hamiltonian is expressed in terms of fundamental Fermi fields only.
Even more surprising, when B^2 = 4 pi , that sine-Gordon equation is equivalent
to a free massive Dirac theory, in one spatial dimension. ...
Furthermore, we can identify the mass term in the Thirring model
with the sine-Gordon interaction, [eq. 5.13]

$$M = - (A / B^2) N_m \cos(B f)$$

.. to do this consistently ... we must say [eq. 5.14]

$$B^2 / (4 \pi) = 1 / (1 + g / \pi)$$

....[where]... g is a free parameter, the coupling constant [for the Thirring model]...
Note that if B^2 = 4 pi , g = 0 ,
and the sine-Gordon equation is the theory of a free massive Dirac field. ...
It is a bit surprising to see a fermion appearing as a coherent state of a Bose field.
Certainly this could not happen in three dimensions,
where it would be forbidden by the spin-statistics theorem.
However, there is no spin-statistics theorem in one dimension,
for the excellent reason that there is no spin. ...
the lowest fermion-antifermion bound state of the massive Thirring model
is an obvious candidate for the fundamental meson of sine-Gordon theory. ...
equation (4.82) predicts that
all the doublet bound states disappear when B^2 exceeds 4 pi .

This is precisely the point where
the Thirring model interaction switches from attractive to repulsive. ...
these two theories ... the massive Thirring model .. and ... the sine-Gordon equation ...
define identical physics. ...
I have computed the predictions of ...[various]... approximation methods
for the ration of the soliton mass to the meson mass for three values of B^2 :
4 pi (where the qualitative picture of the soliton as a lump totally breaks down),
2 pi, and pi . At 4 pi we know the exact answer ...
I happen to know the exact answer for 2 pi, so I have included this in the table. ...

Method	B^2 = pi	B^2 = 2 pi	B^2 = 4 pi
Zeroth-order weak coupling expansion eq2.13b	2.55	1.27	0.64
Coherent-state variation	2.55	1.27	0.64
First-order weak coupling expansion	2.23	0.95	0.32
Bohr-Sommerfeld eq4.64	2.56	1.31	0.71
DHN formula eq4.82	2.25	1.00	0.50
Exact	?	1.00	0.50

...[eq. 2.13b]

$$E = 8 \sqrt{A} / B^2$$

...[is the]... energy of the lump ... of sine-Gordon theory ...
frequently called 'soliton...' in the literature ...
[Zeroth-order is the classical case, or classical limit.] ...
... Coherent-state variation always gives
the same result as the ... Zeroth-order weak coupling expansion ... .
The ... First-order weak-coupling expansion ...
explicit formula ... is (8 / B^2) - (1 / pi). ...".

Using the Cl(1,25) E8 model constituent mass of the Up and Down quarks and antiquarks, about 312.75 MeV, as the soliton and antisoliton masses,
and setting B^2 = pi and using the DHN formula,
the mass of the charged pion is calculated to be (312.75 / 2.25) MeV = 139 MeV
which is close to the experimental value of about 139.57 MeV.

Why is the value B^2 = pi the special value that gives the pion mass ?

(or, using Coleman's eq. (5.14), the Thirring coupling constant g = 3 pi)

Because B^2 = pi is where the First-order weak coupling expansion substantially coincides with the (probably exact) DHN formula. In other words,

The physical quark - antiquark pion lives where the first-order weak coupling expansion is exact.

Planck Mass as Superposition Fermion Condensate

At a single spacetime vertex, a Planck-mass black hole is the Many-Worlds quantum sum of all possible virtual first-generation particle-antiparticle fermion pairs allowed by the Pauli exclusion principle to live on that vertex.

Once a Planck-mass black hole is formed, it is stable in the E8 model.
Less mass would not be gravitationally bound at the vertex.
More mass at the vertex would decay by Hawking radiation.

There are 8 fermion particles and 8 fermion antiparticles
for a total of 64 particle-antiparticle pairs.
Of the 64 particle-antiparticle pairs, 12 are bosonic pions.

A typical combination should have about 6 pions so
it should have a mass of about .14x6 GeV = 0.84 GeV.

Just as the pion mass of .14 GeV is less than the sum of the masses of a quark and an antiquark, pairs of oppositely charged pions may form a bound state of less mass than the sum of two pion masses.

If such a bound state of oppositely charged pions has a mass as small as .1 GeV,
and if the typical combination has one such pair and 4 other pions,
then the typical combination could have a mass in the range of 0.66 GeV.

Summing over all 2^64 combinations,
the total mass of a one-vertex universe should give a Planck mass roughly around
0.66 x 2^64 = 1.217 x 10^19 GeV.

The value for the Planck mass given in by the 1998 Particle Data Group is 1.221 x 10^19 GeV.

Conformal Gravity+Dark Energy and DE : DM : OM

MacDowell-Mansouri Gravity is described by Rabindra Mohapatra in section 14.6 of his book “Unification and Supersymmetry”:

§14.6. Local Conformal Symmetry and Gravity

Before we study supergravity, with the new algebraic approach developed, we would like to discuss how gravitational theory can emerge from the gauging of conformal symmetry. For this purpose we briefly present the general notation for constructing gauge covariant fields. The general procedure is to start with the Lie algebra of generators X_A of a group

$$[X_A, X_B] = f_{AB}^C X_C, \tag{14.6.1}$$

where f_{AB}^C are structure constants of the group. We can then introduce a gauge field connection h_μ^A as follows:

$$h_\mu \equiv h_\mu^A X_A. \tag{14.6.2}$$

Let us denote the parameter associated with X_A by ε^A. The gauge transformations on the fields h_μ^A are given as follows:

$$\delta h_\mu^A = \partial_\mu \varepsilon^A + h_\mu^B \varepsilon^C f_{CB}^A \equiv (D_\mu \varepsilon)^A. \tag{14.6.3}$$

We can then define a covariant curvature

$$R_{\mu\nu}^A = \partial_\nu h_\mu^A - \partial_\mu h_\nu^A + h_\nu^B h_\mu^C f_{CB}^A. \tag{14.6.4}$$

Under a gauge transformation

$$\delta_{\text{gauge}} R_{\mu\nu}^A = R_{\mu\nu}^B \varepsilon^C f_{CB}^A. \tag{14.6.5}$$

We can then write the general gauge invariant action as follows:

$$I = \int d^4x \, Q_{AB}^{\mu\nu\rho\sigma} R_{\mu\nu}^A R_{\rho\sigma}^B. \tag{14.6.6}$$

Let us now apply this formalism to conformal gravity. In this case

$$h_\mu = P_m e_\mu^m + M_{mn} \omega_\mu^{mn} + K_m f_\mu^m + D b_\mu. \tag{14.6.7}$$

The various $R_{\mu\nu}$ are

$$R_{\mu\nu}(P) = \partial_\nu e_\mu^m - \partial_\mu e_\nu^m + \omega_\mu^{mn} e_\nu^n - \omega_\nu^{mn} e_\mu^n - b_\mu e_\nu^m + b_\nu e_\mu^m, \tag{14.6.8}$$

$$R_{\mu\nu}(M) = \partial_\nu \omega_\mu^{mn} - \partial_\mu \omega_\nu^{mn} - \omega_\nu^{mp} \omega_{\mu,p}^n - \omega_\mu^{mp} \omega_{\nu,p}^n - 4(e_\mu^m f_\nu^n - e_\nu^m f_\mu^n), \tag{14.6.9}$$

$$R_{\mu\nu}(K) = \partial_\nu f_\mu^m - \partial_\mu f_\nu^m - b_\mu f_\nu^m + b_\nu f_\mu^m + \omega_\mu^{mn} f_\nu^n - \omega_\nu^{mn} f_\mu^n, \tag{14.6.10}$$

$$R_{\mu\nu}(D) = \partial_\nu b_\mu - \partial_\mu b_\nu + 2 e_\mu^m f_\nu^m - 2 e_\nu^m f_\mu^m. \tag{14.6.11}$$

The gauge invariant Lagrangian for the gravitational field can now be written down, using eqn. (14.6.6), as

$$S = \int d^4x \, \varepsilon_{mnrs} \varepsilon^{\mu\nu\rho\sigma} R_{\mu\nu}^{mn}(M) R_{\rho\sigma}^{rs}(M). \tag{14.6.12}$$

We also impose the constraint that

$$R_{\mu\nu}(P) = 0, \tag{14.6.13}$$

which expresses ω_μ^{mn} as a function of (e, b). The reason for imposing this constraint has to do with the fact that P_m transformations must be eventually identified with coordinate transformation. To see this point more explicitly let us consider the vierbein e_μ^m. Under coordinate transformations

$$\delta_{GC}(\xi^\nu)e_\mu^m = \partial_\mu \xi^\lambda e_\lambda^m + \xi^\lambda \partial_\lambda e_\mu^m. \tag{14.6.14}$$

Using eqn. (14.6.8) we can rewrite

$$\delta_{GC}(\xi^\nu)e_\mu^m = \delta_P(\xi e^n)e_\mu^m + \delta_M(\xi\omega^{mn})e_\mu^n + \delta_D(\xi b)e_\mu^m + \xi^\nu R_{\mu\nu}^m(P),$$

where

$$\delta_P(\xi^n)e_\mu^m = \partial_\mu \xi^m + \xi^n \omega_\mu^{mn} + \xi^m b_\mu. \tag{14.6.15}$$

If $R^{\mu\nu}(P) = 0$, the general coordinate transformation becomes related to a set of gauge transformations via eqn. (14.6.15).

At this point we also wish to point out how we can define the covariant derivative. In the case of internal symmetries $D_\mu = \partial_\mu - iX_A h_\mu^A$; now since momentum is treated as an internal symmetry we have to give a rule. This follows from eqn. (14.6.15) by writing a redefined translation generator $\bar{P}$ such that

$$\delta_{\bar{P}}(\xi) = \delta_{GC}(\xi^\nu) - \sum_{A'} \delta_{A'}(\xi^m h_m^A), \tag{14.6.16}$$

where A' goes over all gauge transformations excluding translation. The rule is

$$\delta_{\bar{P}}(\xi^m)\phi = \xi^m D_m^C \phi. \tag{14.6.17}$$

We also wish to point out that for fields which carry spin or conformal charge, only the intrinsic parts contribute to D_m^C and the orbital parts do not play any rule.

Coming back to the constraints we can then vary the action with respect to f_μ^m to get an expression for it, i.e.,

$$e_\tau^m f_{\mu m} = -\tfrac{1}{4}[e_m^\lambda e_{n\tau} R_{\mu\lambda}^{mn} - \tfrac{1}{6} g_{\mu\nu} R], \tag{14.6.18}$$

where f_μ^m has been set to zero in R written in the right-hand side.

This eliminates (from the theory the degrees of freedom) ω_μ^{mn} and f_μ^m and we are left with e_μ^m and b_μ. Furthermore, these constraints will change the transformation laws for the dependent fields so that the constraints do not change.

Let us now look at the matter coupling to see how the familiar gravity theory emerges from this version. Consider a scalar field ϕ. It has conformal weight $\lambda = 1$. So we can write a convariant derivative for it, eqn. (14.6.17)

$$D_\mu^C \phi = \partial_\mu \phi - \phi b_\mu. \tag{14.6.19}$$

We note that the conformal charge of ϕ can be assumed to be zero since $K_m = x^2 \partial$ and is the dimension of inverse mass. In order to calculate $\Box^c \phi$ we

start with the expression for d'Alambertian in general relativity

$$\frac{1}{e}\partial_\nu(g^{\mu\nu}eD^C_\mu\phi). \tag{14.6.20}$$

The only transformations we have to compensate for are the conformal transformations and the scale transformations. Since

$$\delta b_\mu = -2\xi^m_k e_{m\mu}, \qquad \delta(\phi b_\mu) = \phi\delta b_\mu = -2\phi f^m_\mu e^\mu_m = +\tfrac{2}{12}\phi R, \tag{14.6.21}$$

where, in the last step, we have used the constraint equation (14.6.18). Putting all these together we find

$$\Box^C\phi = \frac{1}{e}\partial_\nu(g^{\mu\nu}eD^c_\mu\phi) + b_\mu D^c_\mu\phi + \tfrac{2}{12}\phi R. \tag{14.6.22}$$

Thus, the Lagrangian for conformal gravity coupled to matter fields can be written as

$$S = \int e\, d^4x\, \tfrac{1}{2}\phi\Box^C\phi. \tag{14.6.23}$$

Now we can use conformal transformation to gauge $b_\mu = 0$ and local scale transformation to set $\phi = \kappa^{-1}$ leading to the usual Hilbert action for gravity. To summarize, we start with a Lagrangian invariant under full local conformal symmetry and fix conformal and scale gauge to obtain the usual action for gravity. We will adopt the same procedure for supergravity. An important technical point to remember is that, $\Box^C$, the conformal d'Alambertian contains R, which for constant ϕ, leads to gravity. We may call ϕ the auxiliary field.

After the scale and conformal gauges have been fixed,
the conformal Lagrangian becomes a de Sitter Lagrangian.

Einstein-Hilbert gravity can be derived from the de Sitter Lagrangian,
as was first shown by MacDowell and Mansouri (Phys. Rev. Lett. 38 (1977) 739).
(Frank Wilczek, in hep-th/9801184 says that the MacDowell-Mansouri "... approach
to casting gravity as a gauge theory was initiated by MacDowell and Mansouri ...
S. MacDowell and F. Mansouri, Phys. Rev. Lett. 38 739 (1977) ... ,
and independently Chamseddine and West ... A. Chamseddine and P. West Nucl. Phys. B 129, 39 (1977);
also quite relevant is A. Chamseddine, Ann. Phys. 113, 219 (1978). ...".)

The minimal group required to produce Gravity,
and therefore **the group that is used in calculating Force Strengths**,
is the [anti] de Sitter group, as is described by
Freund in chapter 21 of his book Supersymmetry (Cambridge 1986) (chapter 21 is a Non-Supersymmetry chapter leading up to a Supergravity description in the following chapter 22):
"... Einstein gravity as a gauge theory ... we expect a set of gauge fields w^ab_u for the Lorentz group and a further set e^a_u for the translations, ...
Everybody knows though, that Einstein's theory contains but one spin two field, originally chosen by Einstein as g_uv = e^a_u e^b_v n_ab
(n_ab = Minkowski metric).
What happened to the w^ab_u ?
The field equations obtained from the Hilbert-Einstein action by varying the w^ab_u are algebraic in the w^ab_u ... permitting us to express the w^ab_u in terms of the e^a_u ... The w do not propagate ...
We start from the four-dimensional de-Sitter algebra ... so(3,2).
Technically this is the anti-de-Sitter algebra ...
We envision space-time as a four-dimensional manifold M.
At each point of M we have a copy of SO(3,2) (a fibre ...) ...
and we introduce the gauge potentials (the connection) h^A_mu(x)
A = 1,..., 10 , mu = 1,...,4. Here x are local coordinates on M.
From these potentials h^A_mu we calculate the field-strengths (curvature components) [let @ denote partial derivative]
R^A_munu = @_mu h^A_nu - @_nu h^A_mu + f^A_BC h^B_mu h^C_nu
...[where]... the structure constants f^C_AB ...[are for]... the anti-de-Sitter algebra ....
We now wish to write down the action S as an integral over the four-manifold M ... S(Q) = INTEGRAL_M R^A /\ R^B Q_AB
where Q_AB are constants ... to be chosen ... we require
... the invariance of S(Q) under local Lorentz transformations
... the invariance of S(Q) under space inversions ...
...[AFTER A LOT OF ALGEBRA NOT SHOWN IN THIS QUOTE]...
we shall see ...[that]... the action becomes invariant under all local [anti]de-Sitter transformations ...[and]... we recognize ... t he familiar Hilbert-Einstein action with cosmological term in vierbein notation ...
Variation of the vierbein leads to the Einstein equations with cosmological term.
Variation of the spin-connection ... in turn ... yield the torsionless Christoffel connection ... the torsion components ... now vanish.
So at this level full sp(4) invariance has been checked.
... Were it not for the assumed space-inversion invariance ...
we could have had a parity violating gravity. ...
Unlike Einstein's theory ...[MacDowell-Mansouri].... does not require Riemannian invertibility of the metric. ... the solution has torsion ... produced by an interference between parity violating and parity conserving amplitudes.
Parity violation and torsion go hand-in-hand.
Independently of any more realistic parity violating solution of the gravity equations this raises the cosmological question whether
the universe as a whole is in a space-inversion symmetric configuration. ...".

According to gr-qc/9809061 by R. Aldrovandi and J. G. Peireira:
"... If the fundamental spacetime symmetry of the laws of Physics is that given by the de Sitter instead of the Poincare group, the P-symmetry of the weak cosmological-constant limit and the Q-symmetry of the strong cosmological constant limit can be considered as limiting cases of the fundamental symmetry. ...
... N ...[is the space]... whose geometry is gravitationally related to an infinite cosmological constant ...[and]... is a 4-dimensional cone-space in which ds = 0, and whose group of motion is Q. Analogously to the Minkowski case, N is also a homogeneous space, but now under the kinematical group Q, that is, N = Q/L [where L is the Lorentz Group of Rotations and Boosts]. In other words, the point-set of N is the point-set of the special conformal transformations. Furthermore, the manifold of Q is a principal bundle P(Q/L,L), with Q/L = N as base space and L as the typical fiber. The kinematical group Q, like the Poincare group, has the Lorentz group L as the subgroup accounting for both the isotropy and the equivalence of inertial frames in this space. However, the special conformal transformations introduce a new kind of homogeneity. Instead of ordinary translations, all the points of N are equivalent through special conformal transformations. ...
... Minkowski and the cone-space can be considered as dual to each other, in the sense that their geometries are determined respectively by a vanishing and an infinite cosmological constants. The same can be said of their kinematical group of motions: P is associated to a vanishing cosmological constant and Q to an infinite cosmological constant.
The dual transformation connecting these two geometries is the spacetime inversion x^u -> x^u / sigma^2 . Under such a transformation, the Poincare group P is transformed into the group Q, and the Minkowski space M becomes the conespace N. The points at infinity of M are concentrated in the vertex of the conespace N, and those on the light-cone of M becomes the infinity of N. It is concepts of space isotropy and equivalence between inertial frames in the conespace N are those of special relativity. The difference lies in the concept of uniformity as it is the special conformal transformations, and not ordinary translations, which act transitively on N. ..."

Gravity and the Cosmological Constant come from the MacDowell-Mansouri Mechanism and the 15-dimensional Spin(2,4) = SU(2,2) Conformal Group, which is made up of:

3 Rotations
3 Boosts
4 Translations
4 Special Conformal transformations
1 Dilatation

The **Cosmological Constant / Dark Energy** comes from
the **10 Rotation, Boost, and Special Conformal generators**
of the Conformal Group Spin(2,4) = SU(2,2),
so the fractional part of our Universe of the Cosmological Constant
should be **about 10 / 15 = 67% for tree level**.

Black Holes, including **Dark Matter Primordial Black Holes**, are curvature singularities in our 4-dimensional physical spacetime,
and since Einstein-Hilbert curvature comes from the **4 Translations**
of the 15-dimensional Conformal Group Spin(2,4) = SU(2,2)
through the MacDowell-Mansouri Mechanism (in which the generators corresponding to the 3 Rotations and 3 Boosts do not propagate),
the fractional part of our Universe of Dark Matter Primordial Black Holes
should be **about 4 / 15 = 27% at tree level**.

Since **Ordinary Matter** gets mass from the Higgs mechanism
which is related to the **1 Scale Dilatation**
of the 15-dimensional Conformal Group Spin(2,4) = SU(2,2),
the fractional part of our universe of Ordinary Matter
should be **about 1 / 15 = 6% at tree level**.

However,
as Our Universe evolves the Dark Energy, Dark Matter, and Ordinary Matter densities evolve at different rates,
so that the differences in evolution must be taken into account
from the initial End of Inflation to the Present Time.

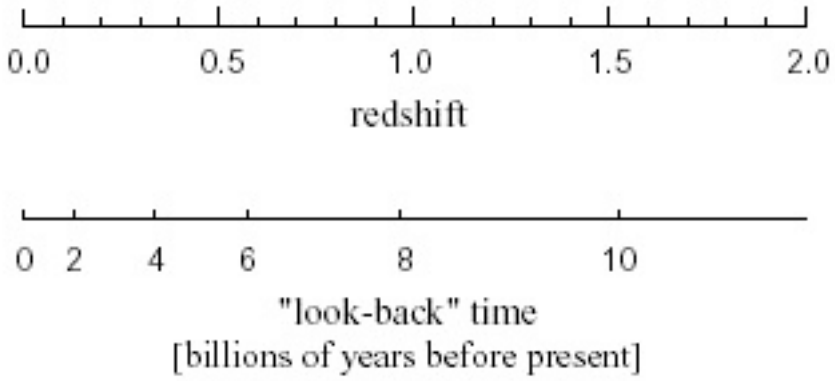
Without taking into account any evolutionary changes with time,
our Flat Expanding Universe should have roughly:

67% Cosmological Constant
27% Dark Matter - possilbly primordial stable Planck mass black holes
6% Ordinary Matter

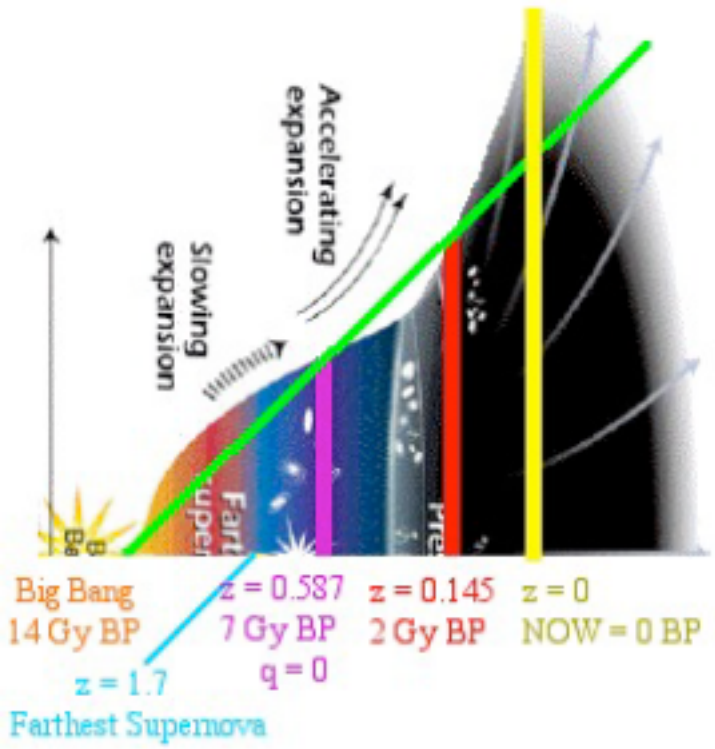
As Dennis Marks pointed out to me,
since density rho is proportional to (1+z)^3(1+w) for red-shift factor z
and a constant equation of state w:
w = -1 for Λ and the average overall density of Λ Dark Energy remains constant
with time and the expansion of our Universe;
and
w = 0 for nonrelativistic matter so that the overall average density of Ordinary
Matter declines as 1 / R^3 as our Universe expands;
and
w = 0 for primordial black hole dark matter - stable Planck mass black holes - so
that Dark Matter also has density that declines as 1 / R^3 as our Universe expands;
so that the ratio of their overall average densities must vary with time, or scale
factor R of our Universe, as it expands.
Therefore,
the above calculated ratio 0.67 : 0.27 : 0.06 is valid
only for a particular time, or scale factor, of our Universe.

When is that time ? Further, what is the value of the ratio now ?

Since WMAP observes Ordinary Matter at 4% NOW,
the time when Ordinary Matter was 6% would be
at redshift z such that
1 / (1+z)^3 = 0.04 / 0.06 = 2/3 , or (1+z)^3 = 1.5 , or 1+z = 1.145 , or z = 0.145.
To translate redshift into time,
in billions of years before present, or Gy BP, use this chart



from a www.supernova.lbl.gov file SNAPoverview.pdf to see that
the time when Ordinary Matter was 6%
would have been a bit over 2 billion years ago, or 2 Gy BP.



In the diagram, there are four Special Times in the history of our Universe:
the Big Bang Beginning of Inflation (about 13.7 Gy BP);

1 - the End of Inflation = Beginning of Decelerating Expansion
(beginning of green line also about 13.7 Gy BP);

2 - the End of Deceleration (q=0) = Inflection Point =
= Beginning of Accelerating Expansion
(purple vertical line at about z = 0.587 and about 7 Gy BP).
According to a hubblesite web page credited to Ann Feild, the above diagram "... reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The more shallow the curve, the faster the rate of expansion. The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart as a faster rate. ...".
According to a CERN Courier web page: "... Saul Perlmutter, who is head of the Supernova Cosmology Project ... and his team have studied altogether some 80 high red-shift type Ia supernovae. Their results imply that the universe was decelerating for the first half of its existence, and then began accelerating approximately 7 billion years ago. ...".
According to astro-ph/0106051 by Michael S. Turner and Adam G. Riess: "... current supernova data ... favor deceleration at $z > 0.5$ ... SN 1997ff at $z = 1.7$ provides direct evidence for an early phase of slowing expansion if the dark energy is a cosmological constant ...".

3 - the Last Intersection of the Accelerating Expansion of our Universe
of Linear Expansion (green line) with the Third Intersection
(at red vertical line at z = 0.145 and about 2 Gy BP),
which is also around the times of the beginning of the Proterozoic Era and Eukaryotic Life, Fe2O3 Hematite ferric iron Red Bed formations, a Snowball Earth, and the start of the Oklo fission reactor. 2 Gy is also about 10 Galactic Years for our Milky Way Galaxy and is on the order of the time for the process of a collision of galaxies.

4 - Now.
Those four Special Times define four Special Epochs:
The Inflation Epoch, beginning with the Big Bang and ending with the End of Inflation. The Inflation Epoch is described by Zizzi Quantum Inflation ending with Self-Decoherence of our Universe (see gr-qc/0007006).
The Decelerating Expansion Epoch, beginning with the Self-Decoherence of our Universe at the End of Inflation. During the Decelerating Expansion Epoch, the Radiation Era is succeeded by the Matter Era, and the Matter Components (Dark and Ordinary) remain more prominent than they would be under the "standard norm" conditions of Linear Expansion.
The Early Accelerating Expansion Epoch, beginning with the End of Deceleration and ending with the Last Intersection of Accelerating Expansion with Linear Expansion. During Accelerating Expansion, the prominence of Matter Components (Dark and Ordinary) declines, reaching the "standard norm" condition of Linear Expansion at the end of the Early Accelerating Expansion Epoch at the Last Intersection with the Line of Linear Expansion.
The Late Accelerating Expansion Epoch, beginning with the Last Intersection of Accelerating Expansion and continuing forever, with New Universe creation happening many times at Many Times. During the Late Accelerating Expansion Epoch, the Cosmological Constant Λ is more prominent than it would be under the "standard norm" conditions of Linear Expansion.
Now happens to be about 2 billion years into the Late Accelerating Expansion Epoch.

What about Dark Energy : Dark Matter : Ordinary Matter now ?

As to how the Dark Energy Λ and Cold Dark Matter terms have evolved
during the past 2 Gy, a rough estimate analysis would be:

Λ and CDM would be effectively created during expansion in their natural ratio
67 : 27 = 2.48 = 5 / 2, each having proportionate fraction 5 / 7 and 2 / 7, respectively;
CDM Black Hole decay would be ignored; and
pre-existing CDM Black Hole density would decline by the same 1 / R^3 factor as Ordinary Matter, from 0.27 to 0.27 / 1.5 = 0.18.

The Ordinary Matter excess 0.06 - 0.04 = 0.02 plus the first-order CDM excess 0.27 - 0.18 = 0.09 should be summed to get a total first-order excess of 0.11, which in turn should be distributed to the Λ and CDM factors in their natural ratio 67 : 27, producing, for NOW after 2 Gy of expansion:

CDM Black Hole factor = 0.18 + 0.11 x 2/7 = 0.18 + 0.03 = 0.21
for a total calculated Dark Energy : Dark Matter : Ordinary Matter ratio for now of

0.75 : 0.21 : 0.04

so that the present ratio of 0.73 : 0.23 : 0.04 observed by WMAP seems to me to be substantially consistent with the cosmology of the E8 model.

2013 Planck Data (arxiv 1303.5062) showed "... anomalies ... previously observed in the WMAP data ... alignment between the quadrupole and octopole moments ... asymmetry of power between two ... hemispheres ... Cold Spot ... are now confirmed at ... 3 sigma ... but a higher level of confidence ...".

E8 model rough evolution calculation is: DE : DM : OM = 75 : 20 : 05
WMAP: DE : DM : OM = 73 : 23 : 04
Planck: DE : DM : OM = 69 : 26 : 05
basic unevolved E8 Conformal calculation: DE : DM : OM = 67 : 27 : 06

Since uncertainties are substantial, I think that there is reasonable consistency.

World-Line String Bohm Quantum Theory

A physically realistic Lattice Bosonic String Theory with Strings = World-Lines and
Monster Group Symmetry
containing gravity and the Standard Model
can be constructed consistently with the E8 physics model
248-dim E8 = 120-dim adjoint D8 + 128-dim half-spinor D8
= (28 + 28 + 64) + (64 + 64)

World-Lines of Particles act as Strings. Andrew Gray in arXiv quant-ph/9712037 said:
"... probabilites are ... assigned to entire fine-grained histories ...
base[d] ... on the Feynman path integral formulation ...
The formulation is fully relativistic and applicable to multi-particle systems.
It ... makes the same experimental predictions as quantum field theory …
consider ... small ... elements ... of ... space and time ... and ... volume ... ---> 0 ...
get the final amplitude ... by considering all possible distributions at a time t earlier ...
[and] ... the interference factor ... between the different possible histories that contain
the distribution of interest there is at each time ... This result is the ...
Feynman amplitude squared times the product of all the interference factors ...".

Luis E. Ibanez and Angel M. Uranga in "String Theory and Particle Physics" said:
"... String theory proposes ... small one-dimensional extended objects, strings,
of typical size Ls = 1/ Ms, with Ms known as the string scale ...
As a string evolves in time, it sweeps out a two-dimensional surface in spacetime,
known as the worldsheet, which is the analog of the ... worldline of a point particle ...
for the bosonic string theory ... the classical string action is the total area spanned by
the worldsheet ... This is the ... **Nambu– Goto action** ...".

In my unconventional view

(image adapted from http://www.blockchaintechnologies.com /)

the red line and the green line are different strings/worldlines/histories and
the world-sheet is the minimal surface connecting them,
carrying the Bohm Potential,
as Standard Model gauge bosons carry Force Potential between Point Particles.

Further, Ibanez and Uranga also said:
"... The string groundstate corresponds to a 26d spacetime tachyonic scalar field T(x).
This **tachyon** ... is ... unstable
...
The massless two-index tensor splits into irreducible representations of SO(24) ...
Its **trace** corresponds to a scalar field, the **dilaton** ϕ, whose vev fixes the string interaction coupling constant gs
...
the **antisymmetric** part is the 26d 2-form field BMN
...
The **symmetric traceless** part is the 26d graviton GMN ...".

Closed string **tachyons** localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions.

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

Joe Polchinski in "String Theory, Volume 1, An Introduction to the Bosonic String" said:
"... we find at m^2 = - 4 / alpha' the tachyon,
and at m^2 = 0 the 24 x 24 states of the graviton, dilaton, and antisymmetric tensor ...".

Must the 24x24 symmetric matrices be interpreted as the graviton ? - !!! NO !!!

The 24x24 Real Symmetric Matrices form the Jordan Algebra J(24,R).

Jordan algebras correspond to the matrix algebra of quantum mechanical states,
that is, from a particle physics point of view,
the configuration of particles in spacetime upon which the gauge groups act.

24-Real-dim space has a natural Octonionic structure of 3-Octonionic-dim space.

The corresponding Jordan Algebra is J(3,O) = 3x3 Hermitian Octonion matrices.

Their 26-dim traceless part J(3,O)o describes the 26-dim of Bosonic String Theory
and
the algebra of its Quantum States,
so that
the 24x24 traceless symmetric spin-2 particle is the Quantum Bohmion.

Joseph Polchinski, in his books String Theory vols. I and II(Cambridge 1998), says: "... the **closed ... unoriented ... bosonic string ... theory** has the maximal 26-dimensional Poincare invariance ... It is possible to have a consistent theory ...[with]... the **dilaton** ... the [**string-**]**graviton** ...[and]... the **tachyon** ...[whose]... negative mass-squared means that the no-string 'vacuum' is actually unstable ... ".
The **dilaton** of E8 Physics sets the Planck scale as the scale for
the 16 dimensions that are orbifolded fermion particles and anti-particles
and the 4 dimensions of the CP2 Internal Symmetry Space of M4xCP2 spacetime.
The remaining 26-16-4 = 6 dimensions are the Conformal Physical Spacetime with Spin(2,4) = SU(2,2) symmetry that produces M4 Physical Spacetime

E8 Physics 26D String Theory Spacetime
10D = 6D Conformal Spacetime + 4D Compact CP2 Internal Symmetry Space
with CP2 = SU(3) / SU(2)xU(1) as unique Compactification
which specifies Gauge Groups of the Standard Model.

If Strings = World Lines and World Lines are past and future histories of particles, then **spin-2 string entities carry Bohm Quantum Potential** with Sarfatti Back-Reaction related to Cramer Transaction Quantum Theory.

Roger Penrose in "Road to Reality" (Knopf 2004) says: "... **quantum** mechanics ... alternates between ... **unitary** evolution **U** ... and state reduction R ...
quantum state **reduction** ... is ... **objective** ... **OR** ...
it is always a gravitational phenomenon ... [A] conscious event ... would be ...
orchestrated OR ... of ... large-scale quantum coherence ... of ... microtubules ...".

String-Gravity produces Sarfatti-Bohm Quantum Potential with Back-Reaction.
It is distinct from the MacDowell-Mansouri Gravity of stars and planets.
The **tachyon** produces the instability of a truly empty vacuum state with no strings.
It is natural, because if our Universe were ever to be in a state with no strings, then tachyons would create strings = World Lines thus filling our Universe with the particles and World-Lines = strings that we see. Something like this is necessary for particle creation in the Inflationary Era of non-unitary Octonionic processes.
Our construction of a 26D String Theory consistent with E8 Physics uses a structure that is not well-known, so I will mention it here before we start:

There are 7 independent E8 lattices, each corresponding to one of the 7 imaginary octionions denoted by iE8, jE8, kE8, EE8, IE8, JE8, and KE8
and related to both D8 adjoint and half-spinor parts of E8
and with 240 first-shell vertices.
An 8th E8 lattice 1E8 with 240 first-shell vertices related to the D8 adjoint part of E8 is related to the 7 octonion imaginary lattices (viXra 1301.0150v2) .
It can act as an effectively independent lattice as part of the basis subsets including {1E8,EE8} and {1E8,iE8,jE8,kE8}.

26D String Theory structure can also be formulated directly in the Root Vector picture using redundancy in the E8 description of Quantum States:

Fermion components carry 8-dim Spacetime information
so E8 / D8 = 8x8 + 8x8 can be reduced to 8+8
Spacetime position and momentum are redundant
so D8 / D4 x D4 = 8x8 can be reduced to 8
Gauge Bosons and Ghosts are redundant
so D4 x D4 = 28+28 can be reduced to 28 = 16 for Gravity + 12 for Standard Model

Elimination of Redundancy gives 8+8 + 8 + 28 = 52-dim F4 with 48 Root Vectors forming a 24-cell plus its dual
52-dim F4 has 26-dim smallest non-trivial representation
which has structure of
J(3,O)o = traceless part of 27-dim exceptional Jordan Algebra J(3,O)
which is the Real version of Complex Fr3(O)
and is
the minimal structure containing the basic information of E8 Physics.
so
E8 Physics Quantum Theory can be formulated in terms of 26-dim J(3,O)o.

The Cl(1,25) E8 AQFT inherits structure from the Cl(1,25) E8 Local Lagrangian

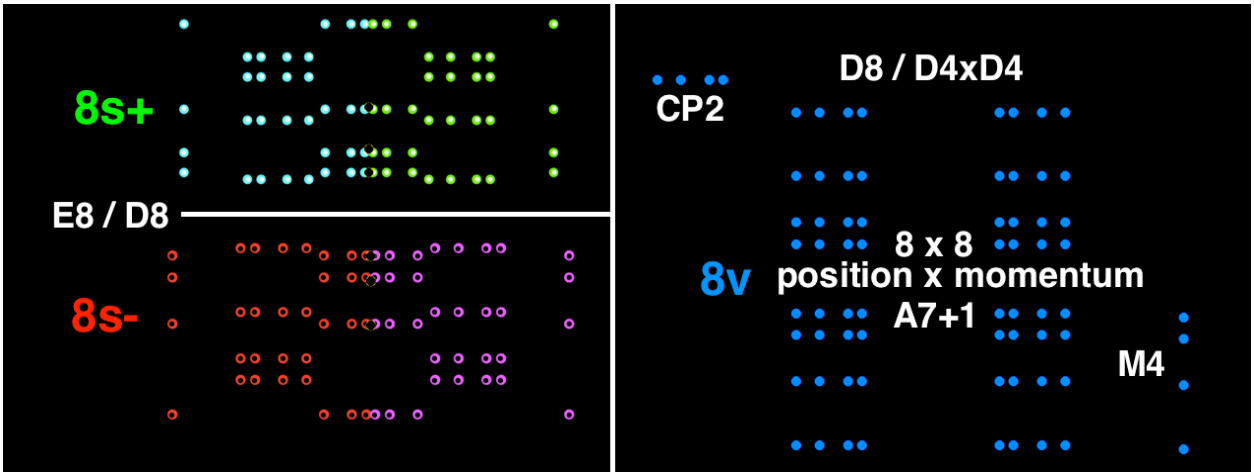
$\int$ Gauge Gravity + Standard Model + Fermion Particle-AntiParticle
8-dim SpaceTime .

whereby World-Lines of Particles are represented by Strings moving in a space whose dimensionality includes 8v = 8-dim SpaceTime Dimensions +
+ 8s+ = 8 Fermion Particle Types + 8s- = 8 Fermion AntiParticle Types
combined in the traceless part J(3,O)o of the 3x3 Octonion Hermitian Jordan Algebra

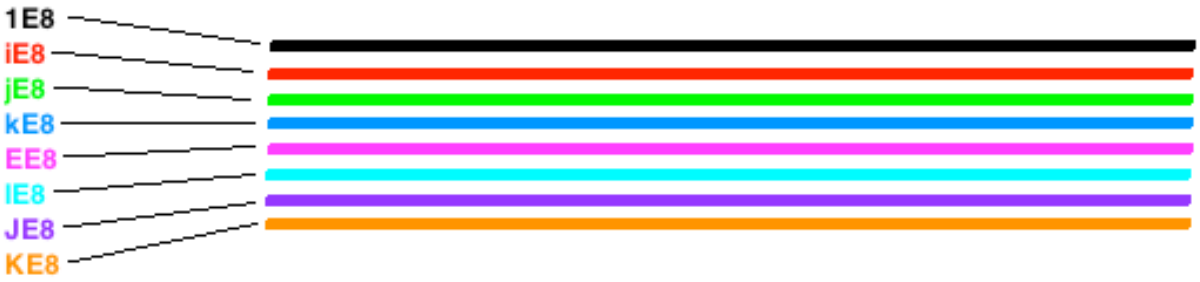
a	8s+	8v
8s+*	b	8s-
8v*	8s-*	-a-b

which has total dimension 8v + 8s+ + 8s- + 2 = 26 and is the space of a
26D String Theory with Strings seen as World-Lines.

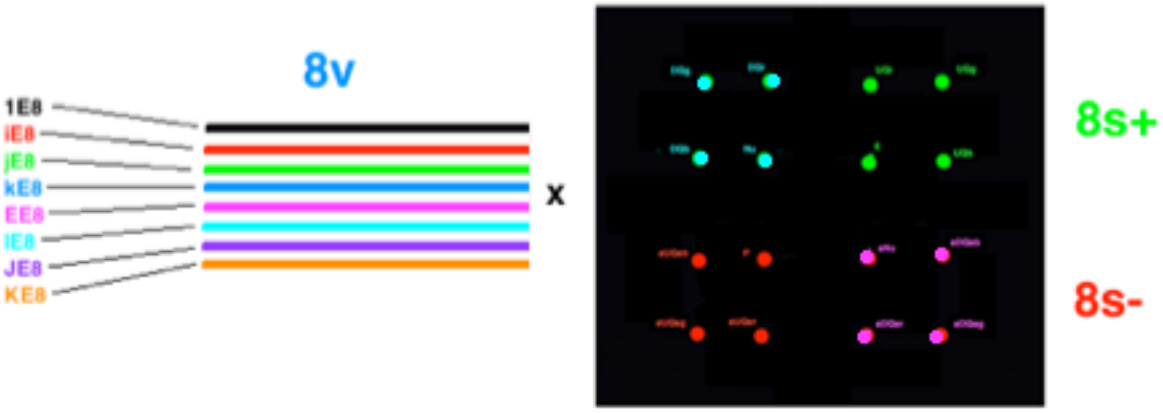
24 = 8v + 8s+ + 8s- of the 26 dimensions of 26D String Theory correspond to 24x8 = 192 of the 240 E8 Root Vectors by representing the 8v + 8s+ + 8s- as superpositions of their respective 8 components



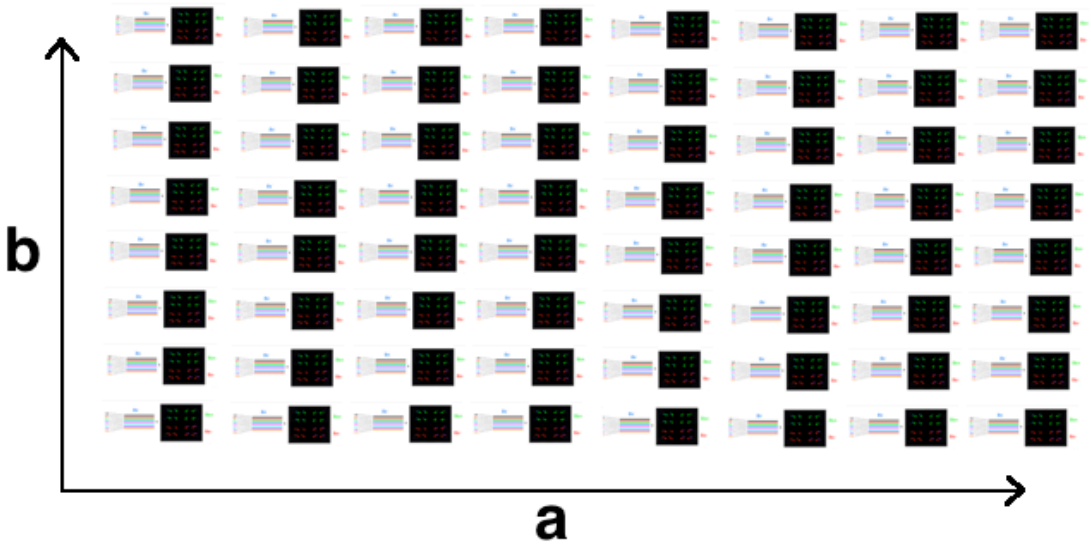
8v SpaceTime is represented by D8 branes. A D8 brane has Planck-Scale Lattice Structure superpositions of 8 types of E8 Lattice denoted by 1E8, iE8, jE8, kE8, EE8, IE8, JE8, KE8



A single Snapshot of SpaceTime is represented by a D8 brane at each point of which is placed Fermion Particles or AntiParticles represented by 8+8 = 16 orbifolded dimensions of the 26 dimensions of 26D String Theory.



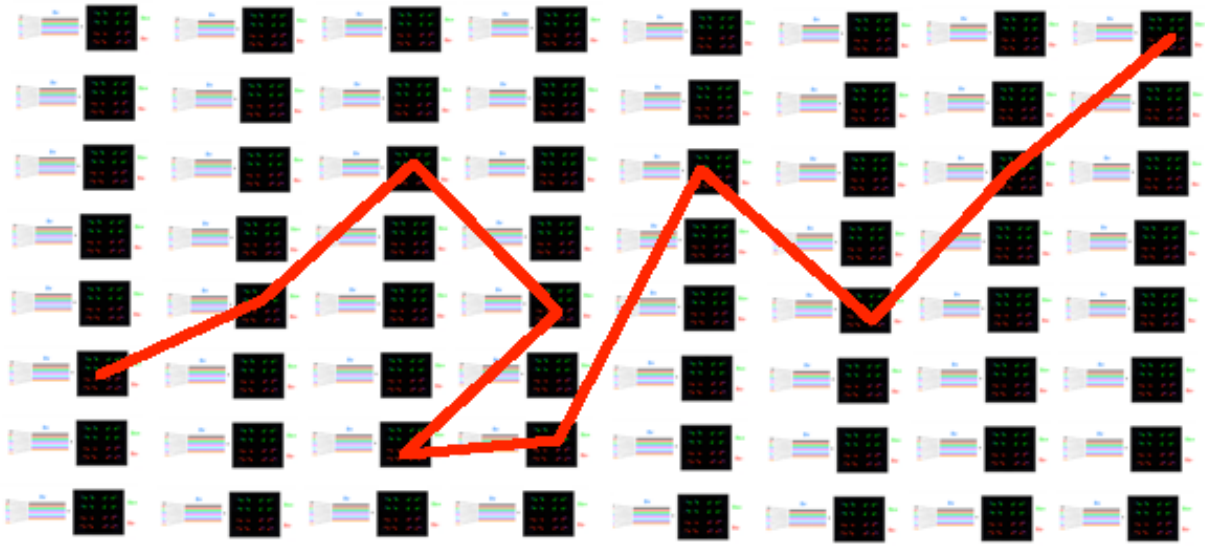
It is necessary to patch together SpaceTime Snapshots to form a Global Structure
describing a Many-Worlds Global Algebraic Quantum Field Theory (AQFT)
whose structure is described by Deutsch in "The Fabric of Reality" (Penguin 1997 pp. 276-283):
"… there is no fundamental demarcation between snapshots of other times and
snapshots of other universes ... Other times are just special cases of other universes ...
Suppose ... we toss a coin ... Each point in the diagram represents one snapshot
... in the multiverse there are far too many snapshots for clock readings alone to locate
a snapshot relative to the others. To do that, we need to consider the intricate detail of
which snapshots determine which others. …
in some regions of the multiverse, and in some places in space,
the snapshots of some physical objects do fall, for a period, into chains,
each of whose members determines all the others to a good approximation …".
The Many-Worlds Snapshots are structured as a 26-dim Lorentz Leech Lattice
of 26D String Theory parameterized by the a and b of J(3,O)o
as indicated in this 64-element subset of Snapshots



The 240 - 192 = 48 = 24+24 Root Vector Vertices of E8 that do not represent
the 8-dim D8 brane or the 8+8 = 16 dim of Orbifolds for Fermions
do represent the **Gauge Bosons (and their Ghosts) of E8 Physics**:

Gauge Bosons from 1E8, iE8, jE8, and kE8 parts of a D8 give U(2,2) Conformal Gravity
Gauge Bosons from EE8 part of a D8 give U(2) Electroweak Force
Gauge Bosons from IE8, JE8, and KE8 parts of a D8 give SU(3) Color Force

Each Deutsch chain of determination represents a World-Line of Particles / AntiParticles corresponding to a String of 26D String Theory
such as the red line in this 64-element subset of Snapshots



26D String Theory is the Theory of Interactions of Strings = World-Lines.

Interactions of World-Lines can describe Quantum Theory

according to Andrew Gray (arXiv quant-ph/9712037): "... probabilites are ... assigned to entire fine-grained histories ... base[d] ... on the Feynman path integral formulation ...
The formulation is fully relativistic and applicable to multi-particle systems.
It ... makes the same experimental predictions as quantum field theory …".
Green, Schwartz, and Witten say in their book "Superstring Theory" vol. 1 (Cambridge 1986)
"... For the ... closed ... bosonic string [**26D String Theory**] .... 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 ...".
Closed string tachyons localized at orbifolds of fermions produce virtual clouds of particles / antiparticles that dress fermions.
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.

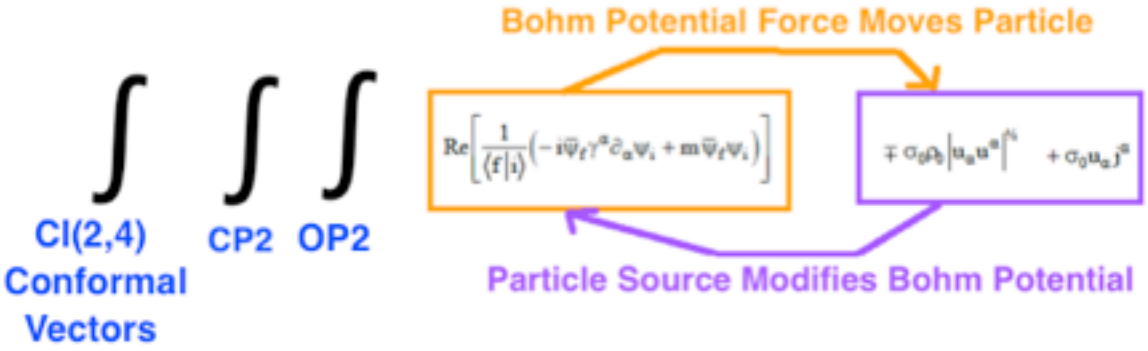
The massless spin 2 state = Bohmion = Carrier of the Bohm Force of the Bohm Quantum Potential.

Roderick Sutherland (arXiv 1509.02442) gave a Lagrangian for the Bohm Potential saying: "... This paper focuses on interpretations of QM in which the underlying reality is taken to consist of particles have definite trajectories at all times ... An example ... is the Bohm model ... This paper ... provid[es]... a Lagrangian ...[for]... the unfolding events ...
... describing more than one particle while maintaining a relativistic description requires the introduction of final boundary conditions as well as initial,
thereby entailing retrocausality ...
In addition ... the Lagrangian approach pursued here to describe particle trajectories also entails the natural inclusion of an accompanying field to influence the particle's motion away from classical mechanics and reproduce the correct quantum predictions.
In so doing, it is ... providing a physical explanation for why quantum phenomena exist at all ... the particle is seen to be
the source of a field which alters the particle's trajectory via self-interaction ...
The Dirac case ... each particle in an entangled many-particle state will be described by an individual Lagrangian density ... of the form:

$$\mathfrak{L} = \mathrm{Re}\left[\frac{1}{\langle f|i\rangle}\left(-i\bar{\psi}_f\gamma^\alpha\partial_\alpha\psi_i + m\bar{\psi}_f\psi_i\right)\right] \mp \sigma_0\rho_0\left|u_\alpha u^\alpha\right|^{½} + \sigma_0 u_\alpha j^\alpha$$

... the ...[first]... term ...[is]... the ... Lagrangian densities for the PSI field alone ...
... sigma_o is the rest density distribution of the particle through space ... j is the current density ...
... rho_o and u are the rest density and 4-velocity of the probability flow ...".

Jack Sarfatti extended the Sutherland Lagrangian to include Back-Reaction entanglement.



where a, b and VM4 form Cl(2,4) vectors and VCP2 forms CP2
and S+ and S- form OP2 so that
26D = 16D orbifolded fermions + 10D and 10D = 6D Conformal Space + 4D CP2 ISS
(ISS = Internal Symmetry Space and 6D Conformal contains 4D M4 of Kaluza-Klein M4xCP2)
saying (linkedin.com Pulse 13 January 2016): "... the reason entanglement cannot be used as a direct messaging channel between subsystems of an entangled complex quantum system, is the lack of direct back-reaction of the classical particles and classical local gauge fields on their shared entangled Bohmian quantum information pilot wave ... Roderick. I. Sutherland ... using Lagrangian field theory, shows how to make the original 1952 Bohm pilot-wave theory completely relativistic,

and how to avoid the need for configuration space for many-particle entanglement.
The trick is that final boundary conditions on the action
as well as initial boundary conditions influence what happens in the present.
The general theory is "post-quantum" ... and it is non-statistical ...
There is complete two-way action-reaction between quantum pilot waves
and the classical particles and classical local gauge fields ...
orthodox statistical quantum theory, with no-signaling ...[is derived]... in two steps,
first arbitrarily set the back-reaction (of particles and classical gauge field on their pilot waves) to zero. This is analogous to setting the curvature equal to zero in general relativity, or more precisely in setting G to zero.
Second, integrate out the final boundary information, thereby adding the statistical Born rule to the mix. ...
the mathematical condition for zero post-quantum back-reaction of particles and classical fields (aka "beables" J.S. Bell's term) is exactly de Broglie's guidance constraint. That is, in the simplest case, the classical particle velocity is proportional to the gradient of the phase of the quantum pilot wave. It is for this reason, that the independent existence of the classical beables can be ignored in most quantum calculations.
However, orthodox quantum theory assumes that the quantum system is thermodynamically closed between strong von Neumann projection measurements that obey the Born probability rule.
The new post-quantum theory in the equations of Sutherland, prior to taking the limit of orthodox quantum theory, should apply to pumped open dissipative structures. Living matter is the prime example. This is a clue that should not be ignored. ...".

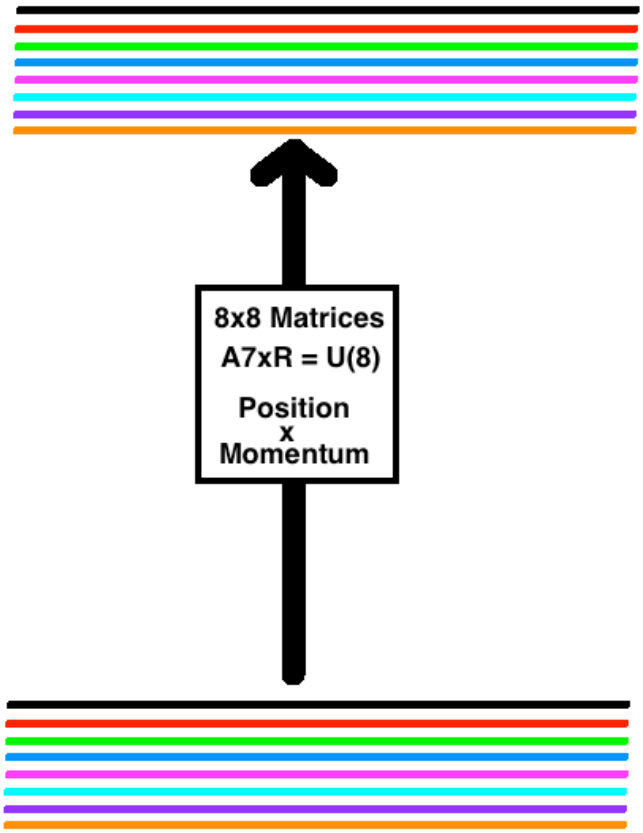
Jack Sarfatti (email 31 January 2016) said: “... Sabine [Hossenfelder]’s argument ...
"... two types of fundamental laws ... appear in contemporary theories.
One type is deterministic, which means that the past entirely predicts the future.
There is no free will in such a fundamental law because there is no freedom.
The other type of law we know appears in quantum mechanics and has an indeterministic component which is random. This randomness cannot be influenced by anything, and in particular it cannot be influenced by you, whatever you think “you” are.
There is no free will in such a fundamental law because there is no “will” - there is just some randomness sprinkled over the determinism.
In neither case do you have free will in any meaningful way.”
... However ...[There is a Third Way]...
post-quantum theory with action-reaction between
quantum information pilot wave and its be-able is compatible with free will. ...”.

The Creation-Annihilation Operator structure of the Bohm Quantum Potential of 26D String Theory is given by the

Maximal Contraction of E8 = semidirect product A7 x h92
where h92 = 92+1+92 = 185-dim Heisenberg algebra and A7 = 63-dim SL(8)

The Maximal E8 Contraction A7 x h92 can be written as a 5-Graded Lie Algebra
28 + 64 + (SL(8,R) + 1) + 64 + 28
Central Even Grade 0 = SL(8,R) + 1
The 1 is a scalar and SL(8,R) = Spin(8) + Traceless Symmetric 8x8 Matrices,
so SL(8,R) represents a local 8-dim SpaceTime in Polar Coordinates.
Odd Grades -1 and +1 = 64 + 64
Each = 64 = 8x8 = Creation/Annihilation Operators for 8 components of 8 Fundamental Fermions.
Even Grades -2 and +2 = 28 + 28
Each = Creation/Annihilation Operators for 28 Gauge Bosons of Gravity + Standard Model.

The 8x8 matrices linking one D8 to the next D8 of a World-Line String
give A7xR = U(8) representing Position x Momentum



The Algebraic Quantum Field Theory (AQFT) structure of the Bohm Quantum Potential of 26D String Theory is given by the E8 Physics Local Lagrangian

$\int$ Gauge Gravity + Standard Model + 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**

Cl(1,25) x ...(N times tensor product)... x Cl(1,25)

which is analogous to Fock Space Hyperfinite II1 von Neumann factor algebra
that is based on 2-Periodicity of Complex Clifford Algebras.

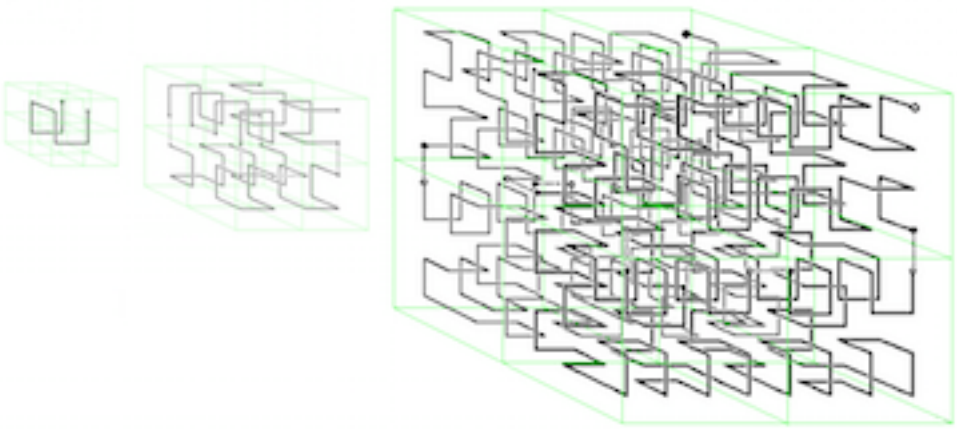
For N = 2^8 = 256 the copies of Cl(1,25) are on the 256 vertices of the 8-dim HyperCube

For N = 2^16 = 65,536 = 4^8 the copies of 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

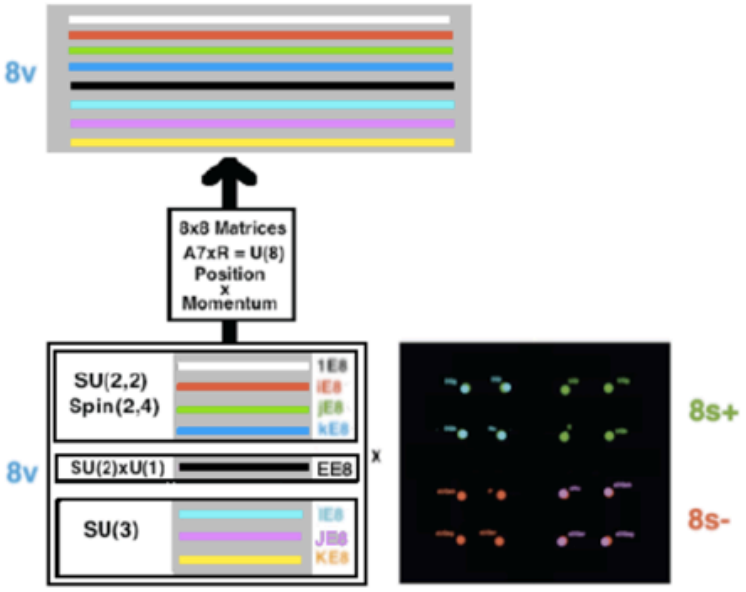
As N grows, the copies of Cl(1,25) continue to fill the 8-dim HyperCube of E8 SpaceTime
using higher Hilbert curve stages from the 8-bit reflected binary Gray code
subdividing the initial 8-dim HyperCube into more and more sub-HyperCubes.

If edges of sub-HyperCubes, equal to the distance between adjacent copies of 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 Wiliam 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



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and ... **SO(24) ... little group of a ...[26-dim]... massless particle** ...
and ... a ... **massless ... spin two state** ...".

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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) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x Cl(8) x 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) 16^64 = (1/2) (2^4)^64 = 2^255 = 6 x 10^76 Fermions.
At the End of Inflation Our Universe had Temperature / Energy 10^27 K = 10^14 GeV
so each of the 10^77 Fermions had energy of 10^14 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 so that the total number created by Inflation was about 10^89.

The End of Inflation time was at about 10^(-34) sec = 2^64 Tplanck
and
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 2^64 qubits created by Inflation is roughly 10^19 which is roughly
the number of Quantum Consciousness Tubulins in the Human Brain.

Therefore

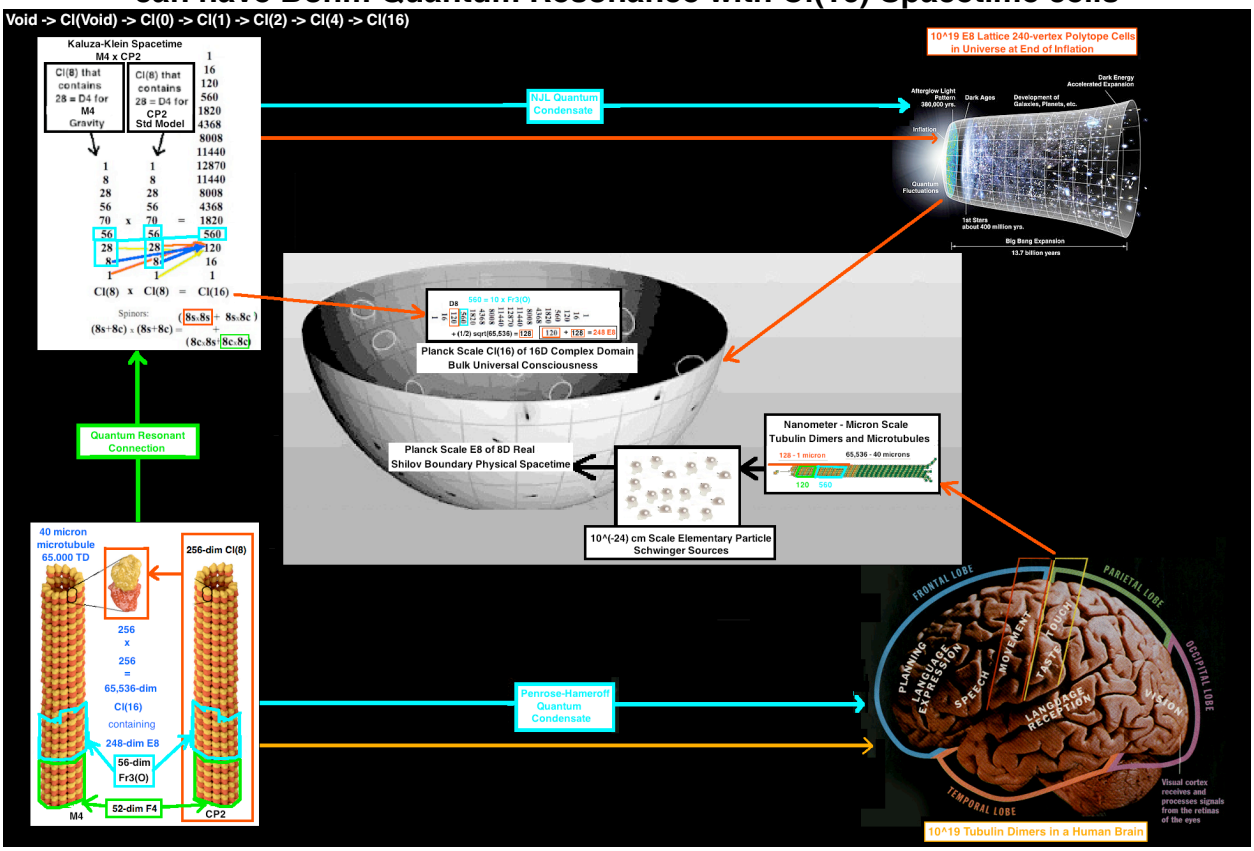
the Human Brain Quantum Consciousness has evolved in Our Universe
to be roughly equivalent
to the Maximum Consciousness of Our Inflationary Era Universe.

Further,
Each cell of E8 Classical 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

(image adapted from 12biophys.blogspot.com Lecture 11)

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 ...".