Weak Gravity Unification with the Quantum Vacuum

Infrared Unification of Scalar Fields has Hidden Monster Group Symmetry

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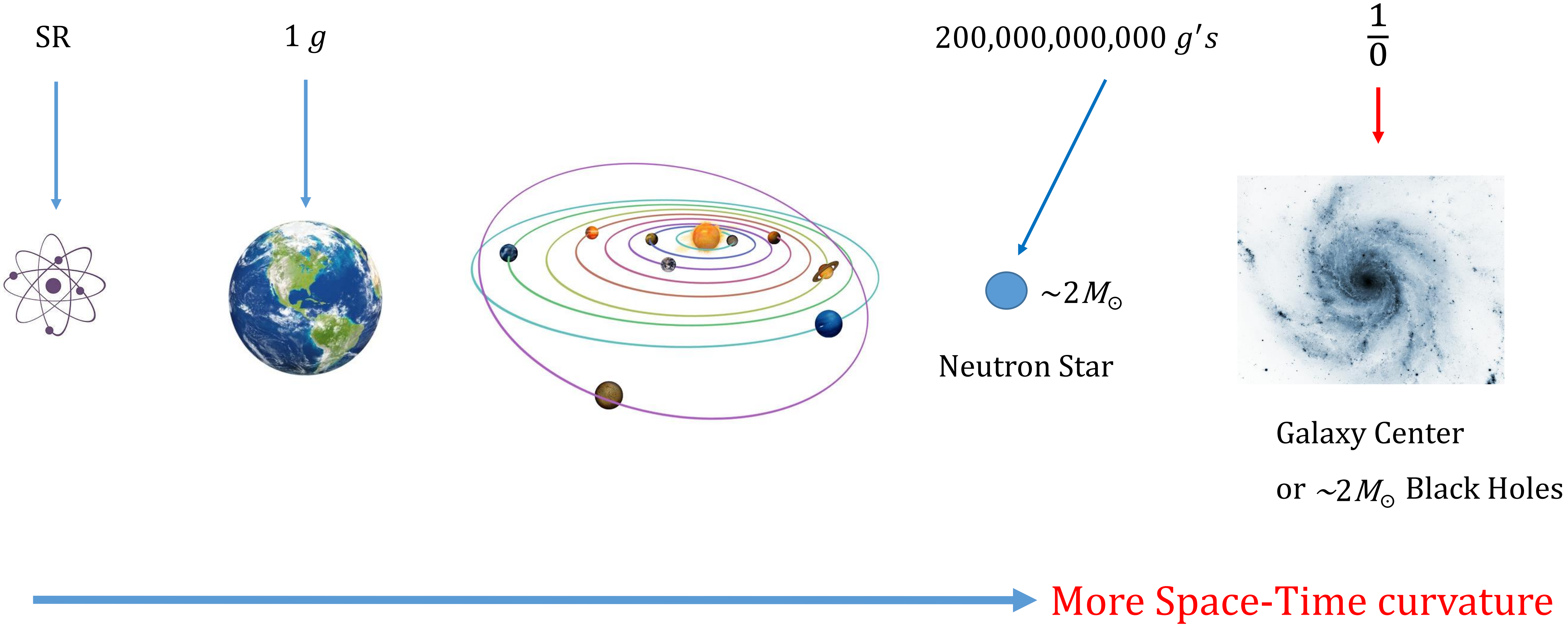
Premise:

A low energy gauge theory coupled to a scalar-tensor has a precise interrelationship to Monster group symmetry across a slight energetic vacuum change from the near flat Minkowski type gentle curving space-time of the regular uud-ddu (proton-neutron) flavor fields to more extremal space-time curvature near a neutron (or black hole) star in the ddu-ddu (neutron^2) flavor fields. The nature of the scalar-tensor only slightly violates EP in the weak gravity realm. In addition it is suggested that a highly symmetric version of Scalar-Tensor Theory is the correct theory operating in the realm of Newton-Einstein Gravity.

Weak Realm of Newton-Einstein Gravity



Not to size scale

The Yang-Mills Double Copy

$$\text{GAUGE THEORY} \times \text{GAUGE THEORY} = \text{GRAVITY AMPLITUDE}$$

OR

$$\text{YANG-MILLS}^{2} \sim \text{GRAVITY}$$

DOUBLE COPY THEORY ALLOWS FOR REPLACEMENT OF COLOR INFORMATION WITH KINEMATICS BY SQUARING THE YANG-MILLS AMPLITUDE TO EQUATE GRAVITY AMPLITUDES

The Yang-Mills Double Copy (cont'd)

<u>IT'S GREAT THAT THERE IS SOME SIMPLICITY</u>
<u>FOR SUCH A COMPLEXITY</u>

YANG-MILLS FORCES HAVE SPIN 1 $\xrightarrow{4}$ VECTOR

GRAVITY FORCE HAS SPIN 2 $\xrightarrow{16}$ TENSOR

$$4^2 = 16$$

A VECTOR HAS 4 SPACETIME COMPONENTS

TWO VECTORS COUPLED CREATE A MATRIX OR TENSOR

The Yang-Mills Double Copy (cont'd)

16 COMPONENTS OF THE METRIC TENSOR IN GENERAL RELATIVITY

$$\text{YANG-MILLS}^2 \sim \text{GRAVITY}$$

The origin of the double copy resides in the BCJ Duality (After Bern-Carassco-Johansson) Which is a perturbative duality between color and kinematics.

Current direction in double copy theories concentrate on high-energy theories involving gluons in supersymmetric models.

GLUONS SQUARED = GRAVITON

The Yang-Mills Double Copy (cont'd)

HOWEVER !

There are now high-energy versions of double copy theory utilising Nambu-Goldstone bosons (pions) These double copy fields correspond to 'special Galileons' which are scalar fields involving kinematics (scaling of scattering amplitudes ?). These pions are represented as gluons in the high-energy higher dimensional theory. (Pion as a light bottom of the hill boson is the mass gap particle due in part to quark 'infrared slavery' at low energy.) How does this break to the low-energy ?

Pions as Gluons in Higher Dimensions

By: Clifford Cheung, Grant N. Remmen,
Chia-Hsien Shen, and Congkao Wena

Is a special Galileon theory relating pions in the higher energy theory as gluons. They introduce dimensional reduction and the Goldstone boson equivalence theorem into the theory.

However, in this presentation the Yang-Mills is ***Synergistically Combined*** with near flat to curved spacetime to produce a very large hidden symmetry namely, the *Monster group symmetry.* This is a hidden symmetry of the high-energy group which breaks to the low-energy potential constructive amplitude of the empty vacuum having local Poincare' symmetry.

Key concepts:

In number theory there is a relation that uses the Heegner number (163) that yields the best ‘near integer value’

$e^{\pi\sqrt{163}} = 262537412640768743.99999999999925\ldots$

Not a coincidence and is explained in *Field Class Theory* through Complex Multiplication (CM)

" *There are* $194-22-9=163$ Z*-independent McKay-Thompson series for the Monster*.“ Conway and Norton 1979

"The genus 0 moonshine groups have $132+1+4+5+13+1+7=163$ equivalence classes with period 1." C. Cummins 2004

Key concepts cont'd:

Flavor fields (Flavor physics): Flavor changes that occur in quarks change properties in larger systems or fields. An example is the proton to neutron conversion which occurs when an up quark (**u**) changes to a down quark (**d**). This is a composition change from **uud** (proton) to **udd** (neutron). As the proton and neutron can be considered as a larger field than its quark ensemble the concept is generalized to proton-neutron (pn) and neutron-neutron (nn) flavor fields. Flavor symmetries are not exact symmetries. Flavor symmetries can be generalized to color fields in the high-energy.

Key concepts cont'd:

The dimension-ful ratio,

$$\frac{h}{G}$$

Or its inverse remains invariant throughout the proton-neutron to neutron-neutron flavor field energetic vacuum changes. This also means that the Planck mass remains invariant. This simplifies the changing vacuum condition requirements.

$$m_P = \sqrt{\frac{hc}{2\pi G}}$$

Key concepts cont'd:

Gravitational coupling constant, not well defined in Physics literature (generally ignored).

It is the dimensionless very weak gravitational coupling force and is analogous to the three gauge forces of the Standard Model of physics which are the electromagnetic, weak and strong force except that it is extremely much weaker (exponentially) than the 3 forces. It is not the same as the Newton constant of gravity which is dimensional. It is difficult to place within the context of the Standard Model.

Key concepts cont'd:

Utilizes two Gravitational coupling constants,

1. For proton-neutron flavor fields (all type proton stars, planetary gravities and microgravity) which reside in a near flat Minkowski like space-time with non-extremal curvature under the Newton-Einstein domains.
2. For neutron-neutron flavor fields which exist in the more extremal space-time curvatures near neutron star type or similar mass black hole. Non-Newtonian, some probable corrections to GR

Key concepts cont'd:

The Monster group symmetry which has order,

808017424794512875886459904961710757005754368000000000

$\sim 10^{54}$ Elements

Lives in a space of 196883 dimensions

In this theory it lies as a hidden symmetry as an amplitude of a compliment of gauge forces and gravity plus 'Beyond the Standard Model'. The perturbation of the vacuum at our low-energy end only allows for Standard Model and Einstein type gravity action with Galileon type scalars and scalar-tensors operating in <u>near</u> lockstep in observable 4-dimensions.

The weak Gravitational coupling constant is of the order,

$$\sim 5.9 \times 10^{-39}$$

The large number,

$$\sqrt[4]{\frac{e}{2}}\; 2\alpha^4\, e^{\frac{\pi}{4\alpha}} = 3.3820235640 \times 10^{38} \ \text{(dimensionless)}$$

α is the 2018 Codata valued fine structure constant,
and $e = 2.718281828459 \ldots$

When divided by 2 and inverted is the proton-neutron Gravitational coupling constant,

$$\left(\sqrt[4]{\frac{e}{2}}\; \alpha^4\, e^{\frac{\pi}{4\alpha}}\right)^{-1} = 5.913619353 \times 10^{-39}$$

This a modified relation taken from Damour where A and B are of natural order unity and ‘t Hooft suggested that B $= \pi/4$

$$\text{Gravitational coupling constant} \simeq Ae^{\frac{-B}{\alpha}}$$

Our large number form is very similar to the physics form,

$$\text{Codata 2018}: \frac{hc}{\pi G m_p m_n} = 3.38164 \times 10^{38}$$

m_p *and* m_n are the proton and neutron particle mass

The quadratic of the famous 'near integer' value is multiplied by 70^2

$$e^{2\pi\sqrt{163}}\,70^2 =$$

337736875876935471466319632506024463200.0000008023…

Where the number 70^2 is related to a solution of a particular Diophantine equation (Edouard Lucas' cannonball problem)

It is close to a physics form which is also a quadratic

$$\frac{hc}{\pi G m_n^2} = 3.37698 \times 10^{38}$$

$$\frac{hc}{\pi G m_n^2} = \frac{m_P^2}{m_n^2}$$

Dividing the pure math form by 2 and inverting gives the weak Gravitational coupling constant (neutron-neutron) at or near the surface of a neutron star

$$\left(\frac{e^{2\pi\sqrt{163}}\,70^2}{2}\right)^{-1} = 5.921769705505\ldots \times 10^{-39}\ (dimensionless)$$

It should be noted that this value is a little larger than the proton-neutron Gravitational coupling constant

$$\text{Codata 2018}: \frac{hc}{\pi G m_p m_n} = 3.38164 \times 10^{38} (\text{dimensionless})$$

$$\sqrt[4]{\frac{e}{2}}\ 2\alpha^4\ e^{\frac{\pi}{4\alpha}} = 3.3820235640 \times 10^{38}\ \ (\text{dimensionless})$$

Codata 2018 : $\frac{hc}{\pi G m_p m_n}$ should be equal to: $\sqrt[4]{\frac{e}{2}}\ 2\alpha^4\ e^{\frac{\pi}{4\alpha}}$

that is $3.3820235640 \times 10^{38}$(dimensionless) as the fine structure constant (2018) is determined very accurate and precise compared to G which is still only determined three to four definite figures only. There are uncertainty’s built into the proton and neutron masses as well but not problematic.

G is problematic as it is has a large spread of experimental values ~ 0.05%. The Codata 2018 value did not solve for a metrologic reliable determination of G.

Codata 2010 presented a G value which gave a closer value to:

$$\sqrt[4]{\frac{e}{2}}\ 2\alpha^4\ e^{\frac{\pi}{4\alpha}} = 3.3820235640 \times 10^{38} \text{ (dimensionless)}$$

$$\text{Codata 2010}: \frac{hc}{\pi G m_p m_n} = 3.38187 \times 10^{38} \text{(dimensionless)}$$

Just saying, however we will stick to using Codata 2018 for this presentation and will not fix any values.

The Heegner number 163 is possibly related to the Monster group via the 194 mini j-functions found in the character table as one reduces the redundancies of the similar mini-functions as one goes down the list 194, 171, and 163.

The number 163 is a discriminant involved in the imaginary quadratic field of class number 1.

The famous j-invariant is used to show that

$$e^{\pi\sqrt{163}} = 262537412640768743.99999999999925\ldots$$

is related to deep mathematics, is not coincidental and also ties it to the Monster group.

An amazing property of $0^2 + 1^2 + 2^2 + 3^2 + .. + 24^2 = 70^2$ is that it is directly related to the Leech Lattice as it used in the construction of the 26 dimensional Lorentzian unimodular lattice $II_{25,1}$ using the Weyl vector:

0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24:70

The quadratic value,

$$e^{2\pi\sqrt{163}}\ 70^2$$

has elements that point to the Leech lattice and the Monster group.

We define 2 new constants using a modified form of the Bose-Einstein distribution:

$$f(E) = \frac{1}{e^{E/_{KT}} - 1}$$

$$Z_{pn} = \sqrt[2048]{\frac{1}{\sqrt[65536]{\sqrt[4]{8e}\ \alpha^4\ e^{\pi/_{4\alpha}}\ \frac{\alpha^4}{2\pi}} - 1}}$$

$$Z_{nn} = \sqrt[2048]{\frac{1}{\sqrt[65536]{\frac{\exp\left(2\pi\sqrt{163}\right) 70^2}{2}\ \frac{\alpha_{nn}^4}{\pi}} - 1}}$$

Using 2018 Codata:

$$Z_{pn} = \sqrt[2048]{\frac{1}{\sqrt[65536]{\sqrt[4]{8e}\,\alpha^4\, e^{\pi/4\alpha}\,\frac{\alpha^4}{2\pi}} - 1}} = 1.0033661022615\ldots$$

The fine structure constant α is good out to 11 figures.

Z_{pn} represents Minkowski like space time with the flavor potential of stable proton-neutron matter to exist.

The neutron-neutron flavor is a slightly larger dimensionless number related to a more extremal space time curvature near or at the surface of a $\sim$2 solar mass neutron star or similar mass black hole. Define the fine structure constant at the slightly higher vacuum energy in the extremal curvature:

$$2\alpha_{nn}^4 \exp\left(\frac{\pi}{4\alpha_{nn}}\right)\sqrt[4]{\frac{e}{2}} = \exp\left(2\pi\sqrt{163}\right)70^2$$

$$\alpha_{nn} = 0.00729744955747..$$

$$Z_{nn} = \sqrt[2048]{\frac{1}{\sqrt[65536]{\frac{\exp\left(2\pi\sqrt{163}\right)70^2}{2}\frac{\alpha_{nn}^4}{\pi}} - 1}} = 1.00336611192047\ldots$$

We can also use the higher energy form of the fine structure constant in the original low energy form to obtain the same Z_{nn} value.

$$Z_{nn} = \sqrt[2048]{\frac{1}{\sqrt[65536]{\sqrt[4]{8e}\,\alpha_{nn}^4 e^{\pi/4\alpha}\,\frac{\alpha_{nn}^4}{2\pi}} - 1}} = 1.00336611192047\ldots$$

Originally we called these two values Z_{pn} and Z_{nn} constants (weak gravitational charge ?) but the forms suggest a Bose Einstein distribution, probably spin 2 particles (gravitons) and the presence of an electromagnetic field via α.

We will not use:

$$2018 \text{ Codata } \frac{hc}{\pi G m_n^2} = 3.37698 \times 10^{38}$$

$$Z_{nn} = \sqrt[2048]{\frac{1}{\sqrt[65536]{\frac{hc}{2\pi G m_n^2}\frac{\alpha^4}{\pi}} - 1}} = 1.0033661131375\ldots$$

Because of the invariance of $\dfrac{h}{G}$ $or = \dfrac{h_{nn}}{G_{nn}}$

m_n should get slightly larger $= m_{n_{nn}}$

because h_{nn} will be slightly larger

2018 Codata still does not resolve the Newton constant issue.

$$\text{Codata 2018}: \frac{hc}{\pi G m_p m_n} = 3.38164 \times 10^{38} \ \text{(dimensionless)}$$

$$\sqrt[4]{\frac{e}{2}}\ 2\alpha^4\ e^{\frac{\pi}{4\alpha}} = 3.3820235640 \times 10^{38} \ \text{(dimensionless)}$$

Since the Planck mass is kept invariant across energetic Vacuum changes the neutron mass can be determined at the nn flavor if the number theory value is correct and G is in the ballpark. However, the $m_{n_{nn}}$ value is too small. Will wait to see future G.

$$\sqrt{\frac{e^{2\pi\sqrt{163}}\ 70^2}{2}} = \frac{m_P}{m_{n_{nn}}} \qquad m_{n_{nn}} = 1.67483 \times 10^{-27}\ \text{kg}$$

The forms for Z_{pn} and Z_{nn} are probability distributions based on gravitons inducing space time curvature including an electromagnetic field as a local condition as isospin degeneracy of matter *SU(2)* symmetry (e.g. towards protonic matter converting to neutronic matter as in degeneracy pressure). Considering the *SU(2)* isospin dynamics of internal symmetries and the distribution population of gravitons the weak gravitational charge changes in response to local environment and reveals the charge to be a dynamic **scalar** (dimensionless). Not as a constant.

Using 2018 Codata for the *SU(2)* group at the flat space low energy we have a double copy Yang-Mills equation:

$$16\, Z_{pn}\ \frac{m_P^2}{m_{e^+e^-}^2}\ \frac{\left(Z_{pn}\pi^+\right)^2}{m_{e^+e^-}^2}\frac{\left(Z_{pn}\pi^-\right)^2}{m_{e^+e^-}^2} = 8.076931\underline{1}859 \times\ 10^{53}$$

$\pi^{+-} = 2.488072118\ \times 10^{-28}\ kg$ (charged pion mass 2018 PDG)

$m_P =$ Planck mass (invariant)

$m_{e^+e^-} = 2\ \times$ electron mass (combined mass of electron and positron)

For the extremal space time curvature at the slightly higher vacuum energy,

$$16\, Z_{nn}\ \frac{m_P^2}{m^2_{e^+_{nn}e^-_{nn}}}\ \frac{\left(Z_{nn}\pi^{+-}_{nn}\right)^2}{m^2_{e^+_{nn}e^-_{nn}}}\frac{\left(Z_{nn}\pi^{+-}_{nn}\right)^2}{m^2_{e^+_{nn}e^-_{nn}}} = 8.07693\underline{1}859 \times\ 10^{53}$$

Because $Z_{xx}\pi^{+-}_{xx}$ is invariant then: $Z_{pn}\pi^{+-} = Z_{nn}\pi^{+-}_{nn}$

$$\pi^{+-}_{nn} = 2.4880720949 \times 10^{-28}\, kg \quad \text{(slightly smaller)}$$

$$m_{e_{nn}} = 9.1093837159972 \times 10^{-31}\, kg \quad \text{(slightly larger)}$$

$$m_{e^+_{nn}e^-_{nn}} = 1.8218767431994 \times 10^{-30}\, kg$$

We have two Yang-Mills double copy relations that appear to:

$$16\, Z_{pn}\ \frac{m_P^2}{m_{e^+e^-}^2}\ \frac{\left(Z_{pn}\pi^+\right)^2}{m_{e^+e^-}^2}\frac{\left(Z_{pn}\pi^-\right)^2}{m_{e^+e^-}^2} = \text{Monster Group Order of Elements}$$

$$16\, Z_{nn}\ \frac{m_P^2}{m_{e_{nn}^+e_{nn}^-}^2}\ \frac{\left(Z_{nn}\pi_{nn}^{+-}\right)^2}{m_{e_{nn}^+e_{nn}^-}^2}\frac{\left(Z_{nn}\pi_{nn}^{+-}\right)^2}{m_{e_{nn}^+e_{nn}^-}^2} = \text{Monster Group Order of Elements}$$

$$16\, Z_{pn}\ \frac{m_P^2}{m_{e^+e^-}^2}\ \frac{\left(Z_{pn}\pi^+\right)^2}{m_{e^+e^-}^2}\frac{\left(Z_{pn}\pi^-\right)^2}{m_{e^+e^-}^2} = 16\, Z_{nn}\ \frac{m_P^2}{m_{e_{nn}^+e_{nn}^-}^2}\ \frac{\left(Z_{nn}\pi_{nn}^{+-}\right)^2}{m_{e_{nn}^+e_{nn}^-}^2}\frac{\left(Z_{nn}\pi_{nn}^{+-}\right)^2}{m_{e_{nn}^+e_{nn}^-}^2}$$

Both relations are invariant to local space time changes and therefore exhibit **Global symmetry.**

We see that there is a change from the near flat Minkowski space time to the more extremal space time near or at neutron stars and black holes.

Z_{xx} is not constant across space time,

$Z_{xx} = T^{\mu v}_{gr} \times T^{\mu v}_{em}$ where $T^{\mu v}$ is the stress energy tensor of GR defined as a scalar and $T^{\mu v}_{em}$ is the electromagnetic stress energy tensor.

Redefine $Z_{xx} = \phi$ (as a dimensionless scalar)

$$16\,\phi\,\frac{m_P^2}{m_{e^+e^-}^2}\,\frac{\left(\phi\pi^+\right)^2}{m_{e^+e^-}^2}\,\frac{(\phi\pi^-)^2}{m_{e^+e^-}^2} = \text{Monster Group Order of Elements}$$

$$16\,\phi^5\ m_P^2\ \frac{\left(\pi^{+-}\right)^4}{m_{e^+e^-}^6} = \text{Monster Group Order of Elements}$$

The Planck mass squared m_P^2 suppresses quantum gravity effects from being observed in the low energy aspect of our Universe.

Also, because global symmetry is present this is not a theory of quantum gravity. Although, the high energy aspect probably has conformal space time. General relativity is the lower limit of this. The lower energy form (from near flat space time to extremal space time) nearly has internal and external symmetry unification but is either trivial or is only approximately so. This is because the Coleman-Mandula theorem disallows lie algebra unifications in non-conformal space. However, it looks that the high energy form does have lie algebra (internal external) unifications.

How does the symmetry of conformal space time in the high energy form (hidden symmetry) relate to the low energy form?

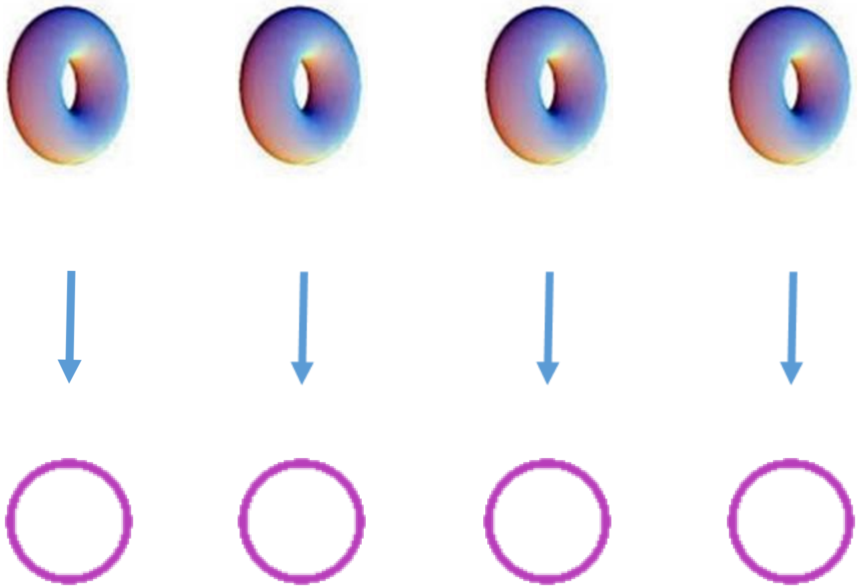
The low energy form has combined gravitational and electromagnetic tensors embedded in the scalar suggesting Kaluza-Klein type compactification in a 5^{th} dimension. The KK modes are hidden as Planck length circle compactifications.

The high energy form has conformal symmetries with Planck energy modes compactified as 24 dimensional tori. Probably related to the Monster group.

Hidden Symmetry

24D Tori

High- Energy Conformal



Kaluza-Klein 5^{th} D

Low-Energy GR-Scalar

Local Poincare' Group, General Covariance

The <u>cylinder condition</u> enables 5D to save GR and hence 4 dimensional space time and to allow the Low Energy- High Energy duality.

For comparison will use the past 2014 Codata and 2010 Codata

<u>2014 Codata</u>:

$$16\,\phi^5\; m_P^2\; \frac{\left(\pi^{+-}\right)^4}{m_{e^+e^-}^6} = 8.07709\underline{2}\underline{8}5\ldots \times 10^{53}$$

<u>2010 Codata</u>:

$$16\,\phi^5\; m_P^2\; \frac{\left(\pi^{+-}\right)^4}{m_{e^+e^-}^6} = 8.07739320\ldots \times 10^{53}$$

FUTURE DIRECTIONS ➡

Preferably Codata (2022) gets better especially the Newton constant. Such that,

$$16\,\phi^5\, m_P^2\, \frac{(\pi^{+-})^4}{m_{e^+e^-}^6} = 8.0801742479\ldots \times 10^{53}$$

… thus approximating the Monster elements to high confidence

Is supersymmetry involved?

Is the Bi-Monster involved?

Is Peccei-Quinn symmetry involved?

Even if all of this turns out to be wrong it was great fun to wonder if such a grand synthesis was possible.

Here are two earlier exploratory works along with their obligatory missteps

https://hal.archives-ouvertes.fr/hal-01232022

https://hal.archives-ouvertes.fr/hal-01580821

“In the mysterious way the scales of the hidden Monster flash iridescently from near impenetrable darkness”

4th Century BC China -*Unknown*