Dimension of the Universe

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Dedicated to my teachers in High School 455 of Kolpino district of St. Petersburg (Leningrad): Anastasia Sergeevna Konovalova (Math) and Nikolai Viktorovich Levashov (Physics and Astronomy).

Abstract
In his first paper on Gravity's Extreme Weakness problem author suggested solution of the problem via Higher Dimensions and Harmonic series and provided the first numerical results supporting this approach.

The present paper demonstrates how Motley String Theory (MST) solves Gravity's Extreme Weakness problem via Higher Dimensions and Harmonic series.

In doing so we establish the intimate link between Newton's Gravity constant N_G and Euler's Gamma γ constant, which together define true dimension of our Universe.

*The amazing link between our Universe Dimension and fundamental Physical and Mathematical constants may be seen as the most direct demonstration so far that the **MST is our Unique Theory of Everything (ToE)!***

Keywords and Phrases: Gravity Extreme Weakness, Motley String Theory (MST), Newton's Gravity constant, Euler's Gamma constant, Motley String based Quantum Mechanics (MSQM), Theory of Everything, ToE.

1. Gravity force extreme weakness

It has been observed that the three fundamental forces the Standard Model accounts for (the Strong, the Weak, and Electromagnetic) have sharp differences in their field strengths (aka coupling constants).

Electromagnetic force is defined by the *fine structure constant*, which is $α = 1/137$.

The Weak force is about 5 times stronger than electromagnetic force.

The Strong force depends on the regime quarks are in (because of quark confinement), and could be anywhere between 1/8 and 1.

But Gravity's strength, as we know from Newtons famous formula, is defined by the Gravitational constant, which was first measured by Henry Cavendish in 1798 to be $G_N = 6, 6726 • 10^{-11} Nm^2/kg^2$ and thus is extremely weak [11]. That is about 10^{-34} times weaker than the Electromagnetic force.

The Big Question (High-Energy) Physicists were asking was *"What makes Gravity so weak"*?

The present paper gives explanation for the Gravity's extreme Weakness based on the Motley String theory.

If a force of Nature *F* is acting uniformly on ALL spacial dimensions that exist in the Universe (which is reasonable to assume, since we know that surrounding us space is isotropic), then we can say that the Grand Total strength F_{total} of the force may be expressed by the formula:

$$F_{total} = \sum_{d=1}^{D_{max}} F_0/d, \qquad (1)$$

where *d* is dimension, D_{max} is the Highest spacial dimension of the Universe and F_0 is the force's strength in a *single* spacial dimension, sort of calibration parameter.

What determines F_3, force strength in the 3 dimensional *domain* of the Universe we find ourselves in?

Clearly, F_3 is defined by some sort of *cut off*, or small part of the total sum above that is detectable and *measurable* in our 3 dimensional domain of the Universe.

This suggests that what we measure today using our *3 dimensional* sensors, lenses and other experimental equipment shows us *only a tiny fraction* of the Grand Total (1) above!

The sum for F_{total} looks much like the *Harmonic series*, well known in the Number Theory [12]:

$$H_n = \sum_{n=1}^{\infty} 1/d \qquad (2)$$

only limited to the first D_{max} elements of the infinite Harmonic series.

Now, let us suppose for a moment that our Universe is either *High Dimensional* or Infinite dimensional and the Harmonic series is about our Big Question.

If these ideas are correct, then all we need to do to find our Universe true dimension is to determine the cut off value D_{max} above, which is the Highest Spacial Dimension of the Universe.

As author proposed in his first paper on Motley String and Gravity [8], this can be done via numerical experiment on high precision computer to check if and when the *3 dimensional part F_3* of the F_{total} is approaching our measured value of Gravitational constant G_N. When we reach that value in a such numerical experiment, we may be confident that we finally got *an idea* about True Dimensionality of our Universe!

2. Motley String Theory in Higher dimensions

Sometime in the middle of 2019 I came to think that Motley String's unique Compactification scheme

$$D(imensions) = time + N^2, \qquad (3)$$

where N is number of *primordial colors* (aka string's tensions T_i) can be applied to ever higher dimensions and thus may lead to totally New type of Theory which by design encompasses ALL previously known String models as well as some unification schemes.

For example, for the first small values of N primordial Colors-Tensions we have:

N=1: 2-dimensional Conformal Field Theory (CFT) analyzed for example in the important BPZ (Belavin, Polyakov, Zamolodchikov) paper [3].

N=2: Gunnar Nordström's original 5-dimensional theory of Gravitation which *unified Gravity and Electromagnetizm* and thus became the **First Ever version of ToE** [1, 5].

N=3: Superstring theory with 9 spacial dimensions [2, 4].

N=5: 26 dimensional Bosonic and Heterotic Strings [4].

N=7: hypothetical *"fluilds"* String author described in [9].

etc, ad infinitum.

This apparent universality of MST is a result of simple condition (3) above and the fact that one can always find "additive" colors R_i, G_i, B_i by rotating the Motley String color diagram similar to the one on Figure 1 below with *N primary colors* by 360/*N*

degrees.

Notice that the larger *N*, the easier to find matching "additive" colors and thus to achieve *faster Universe splitting and brunching* required for the Many Worlds Interpretation (aka **MWI)** of the Quantum Mechanics, for which Motely String provides *backbone implementation* [10].
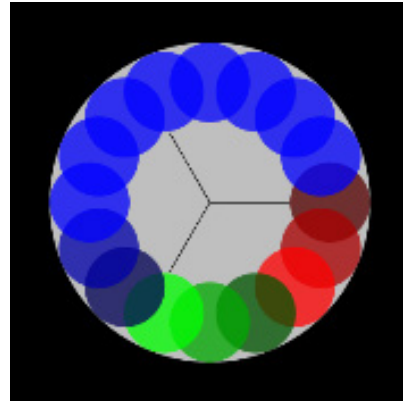

Figure 1: Motley String with 4 primordial Colors-Tensions

In July 2019 I devised an Experiment based on the Idea that Vector Bosons $W^{\pm}$, Z may live in a Higher Dimensional part of our Universe. This is the consequence of Bosonic String (describing messenger particles in String theories) having critical dimension $26 = 1 + 5^2$, with Fermions (matter particles) living in a $10 = 1 + 3^2$ dimensional part of the Universe (according to the Superstring and the Heterotic String models). Motley String theory compactification scheme: $D(imensions) = 1 + N^2$, where N is number of primordial Colors-Dimensions, works equally well for both models.

In early August 2019 I submitted my Experiment Proposal to CERN managers, and later posted it on Research Gate in the form of Questions to ATLAS, CMS, LHCb and other Project teams. The Idea was to Scatter real (not virtual) Bosons in a replica of hadrons Scattering experiments of 1960s-1970s using beams of *Real* Vector Bosons used in 1983 experiments on Super Proton Synchrotron (SPS) when $W^{\pm}$, Z bosons were discovered. See my proposal for details [7].

As you can check for yourself, those Questions on Research Gate got quite an attention from many Researchers: several recommendations and many replies. Stanford accelerator team was (and still is!) especially curious about my Experiment Proposal. Possibly one day they will carry out the proposed Experiment with God's Help.

The Proposal is based on the *Postulate 1* of Motley String theory that EVERY SPACIAL Dimension of the Motley String has its OWN TENSION $T(i)$ and BOSONS (for example $W^{\pm}$ and Z) live in a HIGHER Dimensional Space-time compared with matter particles like Hadrons. Interestingly, the Heterotic string model ALSO suggests this.

Which again confirms that our assumption of High Dimensional Universe is quite natural and justified.

Table 1 below (from my first paper on Gravity) gives you an idea

about first values of ratio F_3/F_{total} for the first considerably large values of Universe highest spacial dimension D_{max}.
$F_3 = 1 + 1/2 + 1/3 = 11/6 = 1.833333$.

D_{max}	F_3/F_{total}	$H(D_{max})$
100	0.3541046	5.1773777
1000	0.43978869	6.2530030
10^6	0.15162992	8.3373373
10^9	0.14659623	14.590340
$2 \cdot 10^9$	0.10994717	16.674674

The first numerical results above confirmed that F_3/F_{total} ratio decreases *slowly but surely* with increase of the highest spacial dimension D_{max}, thereby encouraging authors original guess that such numerical experiment may indeed support the notion that our Universe is either High Dimensional or Infinite dimensional.

Which was actually expected result because for large enough N we have the following estimation for the Harmonic series via Euler's Gamma γ:

$$H_N = \sum_{n=1}^{N} 1/d = lnN - \gamma, \tag{4}$$

where Euler's gamma constant is given by the following expression

$$\gamma = \lim_{n \to \infty} \left(\sum_{n=1}^{N} 1/n - ln(N) \right)$$

Therefore, the ratio F_3/F_{total} will become as low as we need it to be for sufficiently large values of the highest dimension D_{max} of the Universe and thus will explain the extreme weakness of the Gravity force *spread over all higher dimensions.*

3. Numerical results of Java program based on Big Integer class

Simple Java program utilizing BigInteger class API author wrote for this numerical experiment demonstrated that for $N = 7200000001$ first members, the sum of Harmonic series H_N gets only slightly above 22 (22, 12013186, to be precise), which results in $F_3/H_n = 0.08288076270$, that is way way higher than the Newton's gravity constant we are interested in approaching via such program!

Moreover, increasing the initial value of N, used by BigInteger ("string") constructor for summing up, by only 10 times (one zero added to the initial string), at some point results in Java program producing "Infinity" instead of a Big Integer, which is a No Go (full stop) point for such numerical experiment on authors budget PC.

On the other hand, data readily available on mathworld.wolfram.com web site implies that Harmonic series will reach modest value 100 after Astronomic number of members $1,509 * 10^{43}$ have been summed up!

This in turn suggests that we should use *estimation* of the Har-

monic series (4) above provided by Great Euler.

4. The Holy Trinity of Science

Based on our initial (and well justified) assumption we begin with the following Estimation

$$F_3/F_{total} = G_N, \tag{5}$$

linking Gravity's force strength F_3 in our 3 dimensional part of the Universe, total Gravity Force F_{total} in the Universe and Newton's Gravity constant G_N.

Euler's estimation of Harmonic series in (4) gives us the following estimation for the F_{total}:

$$F_{total} = ln\, D_{max} - \gamma, \tag{6}$$

where $\gamma = 0.5772156649$ is Euler's gamma constant and D_{max} is our Universe dimension.

Since our own numerical results obtained via Java Big Integer class and results available on the web site mentioned above indicate that number of Harmonic series members to be summed up in order to get Big enough F_{total} is Astronomical, we have good reasons to use the following estimation for the D_{max}

$$ln\, D_{max} - \gamma = F_3/G_N = \frac{11}{6G_N} \tag{7}$$

And from the equation above we obtain the following for the D_{max}

$$D_{max} = \exp\left(\frac{11}{6G_N} + \gamma\right) \tag{8}$$

This formula for D_{max} is amazing because it reveals the intimate link between **three fundamental constants:** Euler's gamma constant, Newton's Gravity constant and our Universe Dimension!

The Holy Trinity of Science manifested!!!

5. Conclusion

Based on the first results of numerical experiment author described in his first paper on Gravity, we provided estimation for our Universe true Dimension D_M, which turns out to be Huge but Limited Astronomical Number.

For the intermediate value of D_M found inside exp(...) in formula (8), Java program gives the following value:
$temp_M = 2.747554676915274E9$.

Not surprisingly, this intermediate value is still too big for the Java system running on budget PC and **"Infinity"** is displayed at the last step implementing formula (8) above.

To be able to find out the exact number of our Universe Dimensions (which is VERY BIG Astronomical Number) one may

need to run the Dimension program on Supercomputer with *High Precision Math coprocessor.*

Universities and *R&D* departments of Large Companies interested in this Research are welcome to get in touch to discuss things. It may be possible to obtain the exact number D_M instead of estimations on powerful Super computer.

The number D_M may be used, for example, in New Feynman Path Integral formulation instead of Infinity thus making things much more clear and consistent in Quantum Mechanics.

New formulation of the Quantum Mechanics based on Motley String theory (**MSQM**) needs to be based on the fact that our Universe is Very High Dimensional and *Not* Infinite dimensional as some authors of popular science books have expected.

In the present paper we have solved Gravity's ExtremeWeakness problem via Motley String Higher Dimensions and Harmonic series and established the amazing **Link between Natures three fundamental constants:** γ, G_N **and** D_M!

This new Fundamental Link demonstrated one more time that Motley String Theory is our *Unique Theory of Everything!*

Thanks God!

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