On the mathematical connections between some formulas concerning the Shapiro-Virasoro model, D-Brane Amplitudes in String Theory, Ramanujan expression for the Golden Ratio and ζ(2). II

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Abstract

In this paper we describe and analyze the mathematical connections between some formulas concerning the Shapiro-Virasoro model, D-Brane Amplitudes in String Theory, Ramanujan expression for the Golden Ratio and ζ(2)

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We want to highlight that the development of the various equations was carried out according an our possible logical and original interpretation

For more information on the data entered for the development of the various equations, see the "Observations" section.

Now, we have that:

From:

String Theory
University of Cambridge Part III Mathematical Tripos
David Tong - arXiv:0908.0333v3 [hep-th] 23 Feb 2012

The Four-Point Amplitude

We will compute only the four-point amplitude for two-to-two scattering of tachyons. The $\mathrm{Vol}(SL(2;\mathbb{C}))$ factor is there to remind us that we still have a remnant gauge symmetry floating around. Let's now fix this. As we mentioned before, it provides enough freedom for us to take any three points on the plane and move them to any other three points. We will make use of this to set

$$z_1 = \infty \quad , \quad z_2 = 0 \quad , \quad z_3 = z \quad , \quad z_4 = 1$$

Inserting this into the amplitude (6.9), we find ourselves with just a single integral to evaluate,

$$\mathcal{A}^{(4)} \sim g_s^2 \, \delta^{26}(\sum_i p_i) \int d^2z \, |z|^{\alpha' p_2 \cdot p_3} |1-z|^{\alpha' p_3 \cdot p_4} \tag{6.10}$$

(There is also an overall factor of $|z_1|^4$, but this just gets absorbed into an overall normalization constant). We still need to do the integral. It can be evaluated exactly in terms of gamma functions. We relegate the proof to Appendix 6.5, where we show that

$$\int d^2z \, |z|^{2a-2} |1-z|^{2b-2} = \frac{2\pi \Gamma(a)\Gamma(b)\Gamma(c)}{\Gamma(1-a)\Gamma(1-b)\Gamma(1-c)} \tag{6.11}$$

where $a+b+c=1$.

Four-point scattering amplitudes are typically expressed in terms of Mandelstam variables. We choose p_1 and p_2 to be incoming momenta, and p_3 and p_4 to be outgoing momenta, as shown in the figure. We then define

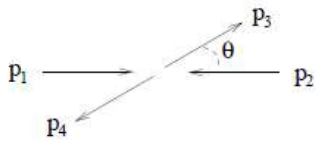


Figure 36:

$$s = -(p_1+p_2)^2 \quad , \quad t = -(p_1+p_3)^2 \quad , \quad u = -(p_1+p_4)^2$$

These obey

$$s+t+u = -\sum_i p_i^2 = \sum_i M_i^2 = -\frac{16}{\alpha'}$$

where, in the last equality, we've inserted the value of the tachyon mass (2.27). Writing the scattering amplitude (6.10) in terms of Mandelstam variables, we have our final answer

$$\mathcal{A}^{(4)} \sim g_s^2 \, \delta^{26}(\sum_i p_i) \, \frac{\Gamma(-1-\alpha' s/4)\Gamma(-1-\alpha' t/4)\Gamma(-1-\alpha' u/4)}{\Gamma(2+\alpha' s/4)\Gamma(2+\alpha' t/4)\Gamma(2+\alpha' u/4)} \tag{6.12}$$

This is the *Virasoro-Shapiro amplitude* governing tachyon scattering in the closed bosonic string.

We have:

$$s + t + u = -\frac{16}{\alpha'}$$

From:

John H. Schwarz - **Superstring theory** - Received 25 May 1982

The $\frac{1}{8}$'s occur because the closed-string Regge slope has been set equal to 1/4, half the open-string slope. (In these units $s + t + u = -32$.)

$\alpha' = 1/4$

From:

Progress of Theoretical Physics, Vol. 51, No. 2, February 1974
On the Vertex Function in the String Model of Hadrons
Tetsuo GOTO and Sigefumi NAKA

$$F(z) = \prod_{n=1}^{\infty} \left(\frac{1}{1-z^{2n}}\right)^4 \exp\left[-\frac{s}{\pi\kappa} \ln \prod_{n=1}^{\infty}(1-z^{2n})\right]$$

$$\times \exp\left[\frac{s-4m^2}{9\pi\kappa} \ln \prod_{n=1}^{\infty}\left(\frac{1-z^{2n}}{1+z^{2n}}\right)\right] \exp\left[\frac{2(t-u)}{9\pi\kappa} \ln \sum_{n=1}^{\infty}\left(\frac{1-z^{2n-1}}{1+z^{2n-1}}\right)\right]$$

$$= \prod_{n=1}^{\infty}\left(\frac{1}{1-z^{2n}}\right)^{(s/\pi\kappa)+4} \prod_{n=1}^{\infty}\left(\frac{1-z^{2n}}{1+z^{2n}}\right)^{(s-4m)/9\pi\kappa} \prod_{n=1}^{\infty}\left(\frac{1-z^{2n-1}}{1+z^{2n-1}}\right)^{2(t-u)/9\pi\kappa}.$$

Although $F(z)$ has essential singularities at $z=\pm 1$, it makes no trouble in integrating (4·4) because the infinite products in (4·7) oscillate rapidly if z goes up to $+1\pm i\delta(\delta\to 0)$. Moreover, as will be shown shortly, exponential factors are represented by the same infinite product form as that appearing in (4·7).

$$\tilde{A}(s,t) = \frac{g_0^2}{2\pi\kappa}\frac{1}{\sin\pi\alpha(s)}\int_c dz(-z)^{-\alpha(s)-1}\tilde{F}(z), \qquad (5\cdot3)$$

where

$$\tilde{F}(z) = \prod_{n=1}^{\infty}\left(\frac{1}{1-z^{2n}}\right)^4 \cdot \prod_{n=1}^{\infty}\left(\frac{1-z^{2n}}{1+z^{2n}}\right)^{(s-4m^2)/9\pi\kappa} \prod_{n=1}^{\infty}\left(\frac{1-z^{2n-1}}{1+z^{2n-1}}\right)^{2(t-u)/9\pi\kappa}. \qquad (5\cdot4)$$

$\kappa = (8\pi)^{(1/2)} * (1.616255e\text{-}35) = 8.102701 \times 10^{-35}$ or $\kappa = 2$

We have:

$$s + t + u = -\frac{16}{\alpha'}$$

The $\frac{1}{8}$'s occur because the closed-string Regge slope has been set equal to 1/4, half the open-string slope. (In these units $s + t + u = -32$.)

For:

s + t + u = -16/(1/4) = -16/0.25 = -64; s = -16; t = -16; u = -32 and z = 1.00778;

$\kappa = 2$

From

$$\prod_{n=1}^{\infty}\left(\frac{1}{1-z^{2n}}\right)^{(s/\pi\kappa)+4} \prod_{n=1}^{\infty}\left(\frac{1-z^{2n}}{1+z^{2n}}\right)^{(s-4m)/9\pi\kappa} \prod_{n=1}^{\infty}\left(\frac{1-z^{2n-1}}{1+z^{2n-1}}\right)^{2(t-u)/9\pi\kappa}.$$

we obtain:

Product(1/(1-1.00778^(2n)))^(((-16)/(Pi*2))+4), n = 1..5 * Product(((1-1.00778^(2n))/(1+1.00778^(2n))))^((-16-8)/(9*Pi*2)), n = 1..5

Input interpretation:

$$\left(\prod_{n=1}^{5}\left(\frac{1}{1-1.00778^{2n}}\right)^{-16/(\pi\times2)+4}\right)\prod_{n=1}^{5}\left(\frac{1-1.00778^{2n}}{1+1.00778^{2n}}\right)^{(-16-8)/(9\pi\times2)}$$

Result:

$-4.03541\times10^{13} - 1.9854\times10^{13}\,i$

(-4.03541×10^13 - 1.9854×10^13 i) * Product(((1-1.00778^(2n-1))/(1+1.00778^(2n-1))))^((2(-16+32)/(9*Pi*2))), n = 1..5

Input interpretation:

$$(-4.03541\times10^{13} - 1.9854\times10^{13}\,i)\prod_{n=1}^{5}\left(\frac{1-1.00778^{2n-1}}{1+1.00778^{2n-1}}\right)^{2\times(-16+32)/(9\pi\times2)}$$

i is the imaginary unit

Result:

$$3.246\times10^{8} - 2.55879\times10^{7}\,i$$

Input interpretation:

$$3.246\times10^{8} - 2.55879\times10^{7}\,i$$

i is the imaginary unit

Result:

$$3.246000...\times10^{8} - 2.558790...\times10^{7}\,i$$

Polar coordinates:

$r = 3.25607\times10^{8}$ (radius), $\theta = -4.50725°$ (angle)

$3.25607*10^{8}$

From which:

(((((-4.03541×10^13 - 1.9854×10^13 i) * Product(((1-1.00778^(2n-1))/(1+1.00778^(2n-1))))^((2(-16+32)/(9*Pi*2))), n = 1..5))))^1/41

Input interpretation:

$$\sqrt[41]{(-4.03541\times10^{13} - 1.9854\times10^{13}\,i)\prod_{n=1}^{5}\left(\frac{1-1.00778^{2n-1}}{1+1.00778^{2n-1}}\right)^{2\times(-16+32)/(9\pi\times2)}}$$

i is the imaginary unit

Result:

$$1.61297 - 0.00309479\,i$$

Input interpretation:

$1.61297 + i \times (-0.00309479)$

i is the imaginary unit

Result:

1.61297... −
0.00309479... i

Polar coordinates:

$r = 1.61297$ (radius), $\theta = -0.109933°$ (angle)

1.61297 result that is a good approximation to the value of the golden ratio 1.618033988749...

From:

$$\widetilde{F}(z) = \prod_{n=1}^{\infty} \left(\frac{1}{1-z^{2n}}\right)^4 \cdot \prod_{n=1}^{\infty} \left(\frac{1-z^{2n}}{1+z^{2n}}\right)^{(s-4m^2)/9\pi\kappa} \prod_{n=1}^{\infty} \left(\frac{1-z^{2n-1}}{1+z^{2n-1}}\right)^{2(t-u)/9\pi\kappa}.$$

we obtain:

Product(1/(1-1.00778^(2n)))^4, n = 1..5 * Product(((1-1.00778^(2n))/(1+1.00778^(2n))))^((-16-4*4)/(9*Pi*2)), n = 1..5

Input interpretation:

$$\left(\prod_{n=1}^{5} \left(\frac{1}{1-1.00778^{2n}}\right)^4\right) \prod_{n=1}^{5} \left(\frac{1-1.00778^{2n}}{1+1.00778^{2n}}\right)^{(-16-4\times4)/(9\pi\times2)}$$

Result:

$-2.53532 \times 10^{32} - 1.50561 \times 10^{32}\, i$

(-2.53532×10^32 - 1.50561×10^32 i) * Product(((1-1.00778^(2n-1))/(1+1.00778^(2n-1))))^((2(-16+32)/(9*Pi*2))), n = 1..5

Input interpretation:

$$(-2.53532 \times 10^{32} - 1.50561 \times 10^{32}\, i) \prod_{n=1}^{5} \left(\frac{1-1.00778^{2n-1}}{1+1.00778^{2n-1}}\right)^{2\times(-16+32)/(9\pi\times2)}$$

i is the imaginary unit

Result:

$2.13482 \times 10^{27} - 1.96968 \times 10^{21}\, i$

Input interpretation:

$2.13482 \times 10^{27} - 1.96968 \times 10^{21}\, i$

i is the imaginary unit

Result:

$2.13482\ldots \times 10^{27} -$
$1.96968\ldots \times 10^{21}\, i$

Polar coordinates:

$r = 2.13482 \times 10^{27}$ (radius), $\theta = -0.0000528636°$ (angle)

$2.13482*10^{27}$

From the ratio between the two expressions, we obtain:

(2.13482×10^27 - 1.96968×10^21 i) / ((((-4.03541×10^13 - 1.9854×10^13 i) * Product(((1-1.00778^(2n-1))/(1+1.00778^(2n-1))))^((2(-16+32)/(9*Pi*2))), n = 1..5)))

Input interpretation:

$$\frac{2.13482 \times 10^{27} - 1.96968 \times 10^{21}\, i}{(-4.03541 \times 10^{13} - 1.9854 \times 10^{13}\, i) \prod_{n=1}^{5} \left(\frac{1-1.00778^{2n-1}}{1+1.00778^{2n-1}}\right)^{2\times(-16+32)/(9\pi\times 2)}}$$

i is the imaginary unit

Result:

$6.53616 \times 10^{18} + 5.15232 \times 10^{17}\, i$

Input interpretation:

$6.53616 \times 10^{18} + 5.15232 \times 10^{17}\, i$

i is the imaginary unit

Result:

$6.53616\ldots \times 10^{18} +$
$5.15232\ldots \times 10^{17}\, i$

Polar coordinates:

$r = 6.55644 \times 10^{18}$ (radius), $\theta = 4.50719°$ (angle)

$6.55644*10^{18}$

From which:

(((((2.13482×10^27 - 1.96968×10^21 i) / ((((-4.03541×10^13 - 1.9854×10^13 i) * Product(((1-1.00778^(2n-1))/(1+1.00778^(2n-1))))^((2(-16+32)/(9*Pi*2))), n = 1..5)))))))^1/90

Input interpretation:

$$\sqrt[90]{\frac{2.13482 \times 10^{27} - 1.96968 \times 10^{21}\, i}{(-4.03541 \times 10^{13} - 1.9854 \times 10^{13}\, i) \prod_{n=1}^{5} \left(\frac{1-1.00778^{2n-1}}{1+1.00778^{2n-1}}\right)^{2 \times (-16+32)/(9 \pi \times 2)}}}$$

i is the imaginary unit

Result:

$1.61836 + 0.00141454\, i$

Input interpretation:

$1.61836 + 0.00141454\, i$

i is the imaginary unit

Result:

1.61836... +
0.00141454... i

Polar coordinates:

$r = 1.61836$ (radius), $\theta = 0.0500798°$ (angle)

1.61836 result that is a very good approximation to the value of the golden ratio 1.618033988749...

Now, we have that:

$\delta/L \ll 1.\ \varepsilon = \delta/L.$

$$g(n) = \frac{1}{2}(1 + (-1)^n)\frac{\sin \pi n\varepsilon}{\pi n\varepsilon}$$

For n = 2

1/2(1+(-1)^2)*((sin(Pi*2*1/12))) / (Pi*2*1/12)

Input:

$$\frac{1}{2}\left(1+(-1)^2\right)\times\frac{\sin\left(\pi\times 2\times\frac{1}{12}\right)}{\pi\times 2\times\frac{1}{12}}$$

Exact result:

$$\frac{3}{\pi}$$

$3/\pi = g(n)$

Decimal approximation:

0.954929658551372014613302580235086172206757874442738692486...

0.9549296585…. result very near to the following Rogers-Ramanujan continued fraction:

$$\frac{e^{-\frac{\pi}{5}}}{\sqrt{(\varphi-1)\sqrt{5}}-\varphi+1} = 1-\cfrac{e^{-\pi}}{1+\cfrac{e^{-2\pi}}{1+\cfrac{e^{-3\pi}}{1+\cfrac{e^{-4\pi}}{1+\ldots}}}} \approx 0.9568666373$$

= 0.9568666373

Property:

$\frac{3}{\pi}$ is a transcendental number

From

$$h(n) = \frac{1}{2}(1 - (-1)^n)\frac{\sin \pi n\varepsilon}{\pi n\varepsilon}$$

For n = 3

1/2(1-(-1)^3)*((sin(Pi*2*1/12))) / (Pi*2*1/12)

Input:

$$\frac{1}{2}\left(1-(-1)^3\right)\times\frac{\sin\left(\pi\times 2\times\frac{1}{12}\right)}{\pi\times 2\times\frac{1}{12}}$$

Exact result:

$$\frac{3}{\pi}$$

$3/\pi = h(n)$ as above

We have also:

$$\left.\begin{aligned}(P^{(1)})^2=(P^{(1)\prime})^2=\tfrac{1}{2}(p(c)^2-2p(a)^2-2p(b)^2),\\ (P^{(2)})^2=(P^{(2)\prime})^2=-(P^{(2)}P^{(2)\prime})=\tfrac{3}{2}p(c)^2,\end{aligned}\right\}$$

Thence, for:

$\varepsilon = 1/12$; $\kappa = 2$; p(a) = 3; p(b) = 5 ; p(c) = 8; g(n) = 3/Pi ; h(n) = 3/Pi;

$(P^{(1)})^2 = -2$; $(P^{(2)})^2 = 96$; n = 2

From

$$F(z)=\prod_{n=1}^{\infty}\left(\frac{1}{1-z^{2n}}\right)^4\exp\left[\frac{4}{3\pi\kappa}(P^{(2)})^2\sum_{n=1}^{\infty}\frac{g^2(n)}{n}\frac{z^n}{1-z^n}\right]$$

$$\times\exp\left[\frac{4}{3\pi\kappa}(P^{(1)})^2\sum_{n=1}^{\infty}\frac{h^2(n)}{n}\frac{z^{2n}}{1-z^{2n}}\right]$$

$$\times\exp\left[-\frac{4}{9\pi\kappa}(P^{(1)}P^{(1)\prime})\sum_{n=1}^{\infty}\frac{h^2(n)}{n}\frac{z^n}{1-z^n}\right].$$

we obtain:

(1/(1-1.00778^4))^4*exp[(4*96)/(6Pi)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))]* exp[(4*-2)/(6Pi)*9/Pi^2*1/2*(1.00778^4) / ((1-1.00778^4))]* exp[-(4*96)/(18Pi)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))]

Input interpretation:

$$\left(\frac{1}{1-1.00778^4}\right)^4 \exp\left(\frac{4\times 96}{6\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)$$
$$\exp\left(\frac{4\times(-2)}{6\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^4}{1-1.00778^4}\right)\exp\left(-\frac{4\times 96}{18\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)$$

Result:

$8.09831\ldots\times 10^{-167}$

8.09831…*10^{-167}

From which:

1/((((5.35719 × 10^-257 * exp[(4*-2)/(6Pi)*9/Pi^2*1/2*(1.00778^4) / ((1-1.00778^4))] exp[-(4*96)/(18Pi)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))])))^1/(843-47)

Input interpretation:

$$\frac{1}{\sqrt[843-47]{\frac{5.35719}{10^{257}}\exp\left(\frac{4\times(-2)}{6\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^4}{1-1.00778^4}\right)\exp\left(-\frac{4\times 96}{18\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)}}$$

Result:

1.616805569433818446293874302136613491260708132149692544593...

1.616805569433…. result that is a good approximation to the value of the golden ratio 1.618033988749...

and multiplying by 1/10^{35} :

1/10^35*(((1/((((5.35719 × 10^-257 * exp[(4*-2)/(6Pi)*9/Pi^2*1/2*(1.00778^4) / ((1-1.00778^4))] exp[-(4*96)/(18Pi)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))])))^1/(843-47))))

Input interpretation:

$$\frac{1}{10^{35}} \times \frac{1}{843-47\sqrt{\frac{5.35719}{10^{257}}\exp\left(\frac{4\times(-2)}{6\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^4}{1-1.00778^4}\right)\exp\left(-\frac{4\times96}{18\pi}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)}}$$

Result:

$1.61681\ldots \times 10^{-35}$

$1.61681\ldots*10^{-35}$ result practically equal to the value of Planck length

While for (see: **STRING THEORY** - *JOSEPH POLCHINSKI* - Institute for Theoretical Physics - University of California at Santa Barbara - **VOLUME I - An Introduction to the Bosonic String** - Cambridge University Press 2001, 2005)

From:

$$\kappa = (8\pi G_N)^{1/2} = \frac{(8\pi)^{1/2}}{M_P} = (2.43 \times 10^{18}\ \text{GeV})^{-1}\ . \qquad (3.7.26)$$

For $M_P = 4.341\times10^{-9}$ kg , we obtain:

$$\frac{\sqrt{8\pi}}{4.341\times10^{-9}}$$

$1.15486\ldots \times 10^{9}$

$\kappa = 1.15486\ldots*10^{9}$

From

$$F(z) = \prod_{n=1}^{\infty}\left(\frac{1}{1-z^{2n}}\right)^4 \exp\left[\frac{4}{3\pi\kappa}(P^{(2)})^2\sum_{n=1}^{\infty}\frac{g^2(n)}{n}\frac{z^n}{1-z^n}\right]$$

$$\times\exp\left[\frac{4}{3\pi\kappa}(P^{(1)})^2\sum_{n=1}^{\infty}\frac{h^2(n)}{n}\frac{z^{2n}}{1-z^{2n}}\right]$$

$$\times\exp\left[-\frac{4}{9\pi\kappa}(P^{(1)}P^{(1)\prime})\sum_{n=1}^{\infty}\frac{h^2(n)}{n}\frac{z^n}{1-z^n}\right].$$

we obtain:

(1/(1-1.00778^4))^4*exp[(4*96)/(3Pi*1.15486e+9)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))]* exp[(4*-2)/(3Pi*1.15486e+9)*9/Pi^2*1/2*(1.00778^4) / ((1-1.00778^4))]* exp[-(4*96)/(9Pi*1.15486e+9)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))]

Input interpretation:

$$\exp\left(\frac{4\times(-2)}{3\pi\times 1.15486\times 10^9}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^4}{1-1.00778^4}\right)$$
$$\exp\left(-\frac{4\times 96}{9\pi\times 1.15486\times 10^9}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)$$

Result:

1.000000360...

1.000000360…

Input interpretation:

$$\left(\frac{1}{1-1.00778^4}\right)^4\exp\left(\frac{4\times 96}{3\pi\times 1.15486\times 10^9}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)\times 1.000000360$$

Result:

$1.01761...\times 10^6$

1.01761…*10^6

From which:

((((1/(1-1.00778^4))^4*exp[(4*96)/(3Pi*1.15486e+9)*9/Pi^2*1/2*(1.00778^2) / ((1-1.00778^2))]*1.000000360)))^1/29

Input interpretation:

$$\sqrt[29]{\left(\frac{1}{1-1.00778^4}\right)^4\exp\left(\frac{4\times 96}{3\pi\times 1.15486\times 10^9}\times\frac{9}{\pi^2}\times\frac{1}{2}\times\frac{1.00778^2}{1-1.00778^2}\right)\times 1.000000360}$$

Result:

1.611231673413641092844445600983790580790906209496089333605...

1.611231673413….. result that is a very good approximation to the value of the golden ratio 1.618033988749...

From:

M5-Brane and D-Brane Scattering Amplitudes
Matthew Heydeman, John H. Schwarz, and Congkao Wen, - arXiv:1710.02170v3 [hep-th] 29 Dec 2017

We have

$$p^{AB} = \varepsilon^{ab}\lambda_a^A\lambda_b^B = \lambda_a^A\lambda^{Ba} = \lambda_+^A\lambda_-^B - \lambda_-^A\lambda_+^B. \qquad (2)$$

Momentum p = 3.65e-34 J*s = 2.278×10^{-21} MeV (megaelectronvolts)

2.278×10^{-24} GeV (gigaelectronvolts)
$2.278*10^{-24}$

The formulas for the 16 supercharges are

$$q^{AI} = \lambda_a^A\eta^{Ia} \quad \text{and} \quad \tilde{q}_I^A = \lambda_a^A\frac{\partial}{\partial\eta_a^I} \quad I = 1, 2. \qquad (11)$$

and we have the following values for q:

q = 1.633; 2.44948974 or 2.1406951429

Now, ρ and P are polynomials of the arguments, as defined in (75), and (59).

In mathematics, an **argument** of a function is a value that must be provided to obtain the function's result. It is also called an independent variable.

$$P_i(\sigma) = \prod_{j\neq i}\sigma_{ji} \quad i, j = 1, 2, \ldots, n\,, \qquad (59)$$

We put $P_i(\sigma) = 12$ with $P_i = 2$; $\sigma = 6$;

$$\rho_a^A(\sigma) = \sum_{m=0}^{d}\rho_{m,a}^A\sigma^m\,, \quad \chi_a^I(\sigma) = \sum_{m=0}^{d}\chi_{m,a}^I\sigma^m\,, \qquad (75)$$

$\rho_a^A(\sigma) = 24$ with $\rho_a^A = 4$; $\sigma = 6$

and:

$$\chi_a^I(\sigma) = \sum_{m=0}^{d} \chi_{m,a}^I \sigma^m$$

$= 48 = 8 * 6$

Further, we have also that:

$$\mathcal{I}^{\rm DBI} = \det{}' S_n \,, \tag{66}$$

where S_n is an $n \times n$ anti-symmetric matrix with

$$(S_n)_{ij} = \frac{s_{ij}}{\sigma_{ij}}, \quad i,j = 1,2,\ldots,n, \tag{67}$$

where $s_{ij} = (p_i + p_j)^2 = 2p_i \cdot p_j$ are the familiar Mandelstam invariants. Also,

$$\mathrm{Pf}' S_n = \frac{(-1)^{i+j}}{\sigma_{ij}} \mathrm{Pf} S_{i,j}^{i,j} \,, \qquad \det{}' S_n = (\mathrm{Pf}' S_n)^2 \,. \tag{68}$$

Here $S_{i,j}^{i,j}$ means that the i-th and j-th rows and columns of the matrix S_n are removed before computing the Pfaffian or determinant. This is required because S_n has rank $n-2$ if n is even. Then $\det' S_n$ is independent of the choice of i and j and transforms with weight two under $SL(2,\mathbb{C})$ transformations of the σ coordinates. If n is odd, there is no satisfactory nonzero definition. Therefore all nonzero amplitudes of all DBI-like theories must have n even. This includes all three brane theories (D3, D5, M5) that are the main emphasis of this paper.

$$\begin{aligned} I_4 \;=\; & \int \frac{d^4\sigma \, d\mathcal{M}_4}{\mathrm{Vol}(G)} \prod_{i=1}^{2} \delta^5 \left(p_i^{AB} - \frac{\rho_a^A(\sigma_i)\rho^{Ba}(\sigma_i)}{P_i(\sigma)} \right) \delta^4 \left(p_4^{AB} - \frac{\rho_a^A(\sigma_4)\rho^{Ba}(\sigma_4)}{P_4(\sigma)} \right) \\ & \times \prod_{i=1}^{2} \delta^2 \left(q_i^{1I} - \frac{\rho_a^1(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)} \right) \delta^2 \left(q_i^{3I} - \frac{\rho_a^3(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)} \right) \det{}' S_4 \, U(\rho,\sigma) \end{aligned} \tag{80}$$

Now, we have

$$I_4 = \int \frac{d^4\sigma\, d\mathcal{M}_4}{\mathrm{Vol}(G)} \prod_{i=1}^{2} \delta^5\left(p_i^{AB} - \frac{\rho_a^A(\sigma_i)\rho^{Ba}(\sigma_i)}{P_i(\sigma)}\right) \delta^4\left(p_4^{AB} - \frac{\rho_a^A(\sigma_4)\rho^{Ba}(\sigma_4)}{P_4(\sigma)}\right)$$
$$\times \prod_{i=1}^{2} \delta^2\left(q_i^{1I} - \frac{\rho_a^1(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)}\right) \delta^2\left(q_i^{3I} - \frac{\rho_a^3(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)}\right) \det{}' S_4\, U(\rho,\sigma)$$

and we obtain, from

$$\prod_{i=1}^{2} \delta^5\left(p_i^{AB} - \frac{\rho_a^A(\sigma_i)\rho^{Ba}(\sigma_i)}{P_i(\sigma)}\right) \delta^4\left(p_4^{AB} - \frac{\rho_a^A(\sigma_4)\rho^{Ba}(\sigma_4)}{P_4(\sigma)}\right)$$
$$\times \prod_{i=1}^{2} \delta^2\left(q_i^{1I} - \frac{\rho_a^1(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)}\right) \delta^2\left(q_i^{3I} - \frac{\rho_a^3(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)}\right) \det{}' S_4\, U(\rho,\sigma)$$

for δ = 1:

[(2.278e-24 – (24*24)/12) * (2.278e-24 – (24*24)/12) * (1.633-(24*48)/12) * (1.633-(24*48)/12) Det[{0, -1}, {1, 0}]]

Input interpretation:

$$\left(2.278\times10^{-24} - \frac{24\times24}{12}\right)\left(2.278\times10^{-24} - \frac{24\times24}{12}\right)$$
$$\left(1.633 - \frac{24\times48}{12}\right)\left(1.633 - \frac{24\times48}{12}\right)\begin{vmatrix}0 & -1\\ 1 & 0\end{vmatrix}$$

$|m|$ is the determinant

Result:

$2.0517421107455999999999998052554779883968000000000462\ldots \times 10^7$

2.05174211074…*10^7

Performing the integral, where x = σ we obtain:

integrate (2.05174211074559999× 10^7)d^4x

Indefinite integral:

$$\int 2.05174211074559999\times10^7\, d^4x\, dx =$$
$$1.02587105537279999\times10^7\, d^4x^2 + \text{constant}$$

For $\sigma = 6$, we have that:

1.02587105537280000×10^7 * 6^2

Input interpretation:

$1.02587105537280000 \times 10^7 \times 6^2$

Result:

$3.69313579934208 \times 10^8$

369313579.934208

From which, performing the 41th root:

(3.69313579934208 × 10^8)^1/41

Input interpretation:

$\sqrt[41]{3.69313579934208 \times 10^8}$

Result:

1.6179342192643389...

1.6179342192643389…. result that is a very good approximation to the value of the golden ratio 1.618033988749...

From eq. (80), we observe that, there is also

$$\int \frac{d^4\sigma \, d\mathcal{M}_4}{\mathrm{Vol}(G)}$$

If we consider Vol(G) equal to a hypersphere for n = 4, we obtain from the following formula:

$$V_n(r) = \frac{\pi^{n/2}}{\Gamma(\frac{n}{2}+1)} r^n,$$

for r = 4.4e+23 (that is the radius of the observable universe)

(Pi^2 * 4.4e+23) / (gamma(3))

Input interpretation:

$$\frac{\pi^2 \times 4.4 \times 10^{23}}{\Gamma(3)}$$

$\Gamma(x)$ is the gamma function

Result:

$2.17131296823965889614359... \times 10^{24}$

$2.171312968239*10^{24}$

Now, we consider:

$$\frac{1}{2.171312968239 \times 10^{24}} = \frac{\mathcal{M}_4}{Vol(G)}$$

Thence, from

$$I_4 = \int \frac{d^4\sigma\, d\mathcal{M}_4}{\mathrm{Vol}(G)} \prod_{i=1}^{2} \delta^5\left(p_i^{AB} - \frac{\rho_a^A(\sigma_i)\rho^{Ba}(\sigma_i)}{P_i(\sigma)}\right) \delta^4\left(p_4^{AB} - \frac{\rho_a^A(\sigma_4)\rho^{Ba}(\sigma_4)}{P_4(\sigma)}\right)$$
$$\times \prod_{i=1}^{2} \delta^2\left(q_i^{1I} - \frac{\rho_a^1(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)}\right) \delta^2\left(q_i^{3I} - \frac{\rho_a^3(\sigma_i)\chi^{Ia}(\sigma_i)}{P_i(\sigma)}\right) \det{}' S_4\, U(\rho,\sigma)$$

we obtain, in conclusion:

1/(2.17131296823965889614359 × 10^24) * 369313579.934208

Input interpretation:

$$\frac{1}{2.17131296823965889614359 \times 10^{24}} \times 3.69313579934208 \times 10^8$$

Result:

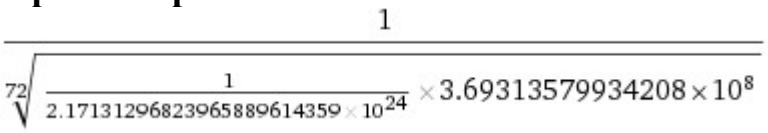
$1.70087677518741266486200785749352767646816731103993 39... \times 10^{-16}$

$1.7008767751874126*10^{-16} = \boldsymbol{I_4}$

From which:

1/((1/(2.17131296823965889614359 × 10^24) * 369313579.934208))^1/72

Input interpretation:



Result:

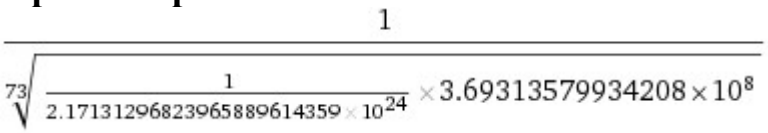
1.6558402402846962...

1.6558402402846962…. result very near to the 14th root of the following Ramanujan's class invariant $Q = \left(G_{505}/G_{101/5}\right)^3$ = 1164.2696 i.e. 1.65578...

and:

1/((1/(2.17131296823965889614359 × 10^24) * 369313579.934208))^1/73

Input interpretation:



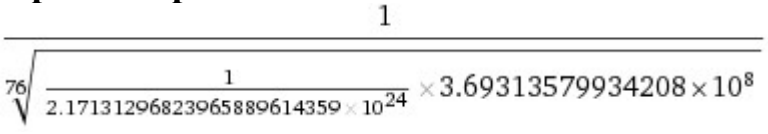
Result:

1.6444405601589508...

1.6444405601589508…. $\approx \zeta(2) = \frac{\pi^2}{6} = 1.644934$ ...

1/((1/(2.17131296823965889614359 × 10^24) * 369313579.934208))^1/76

Input interpretation:



Result:

1.6124681560579138...

1.6124681560579138…. result that is a good approximation to the value of the golden ratio 1.618033988749...

1/((1/(2.17131296823965889614359 × 10^24) * 369313579.934208))^1/77

Input interpretation:

$$\frac{1}{\sqrt[77]{\frac{1}{2.17131296823965889614359\times 10^{24}}\times 3.69313579934208\times 10^{8}}}$$

Result:

1.6024941636662672...

1.602494163662672…

and:

1/3(1.6444405601589508+1.6124681560579138+1.6024941636662672)

Input interpretation:

$$\frac{1}{3}(1.6444405601589508 + 1.6124681560579138 + 1.6024941636662672)$$

Result:

1.619800959961043933333333333333333333333333333333333333333...

Repeating decimal:

$1.6198009599610439\overline{3}$ (period 1)

1.61980095996104393 result that is a good approximation to the value of the golden ratio 1.618033988749...

Now:

As before, we can introduce eight bosonic expressions λ_a^A, where $A = 1, 2, 3, 4$ labels a spinor representation of the 6D Lorentz group $Spin(5, 1)$ and $a = \pm$ labels a doublet of the first $SU(2)$ factor in the little group. In terms of these coordinates the momentum of an on-shell massless particle can be written in the form

$$p^{AB} = \varepsilon^{ab}\lambda_a^A\lambda_b^B = \lambda_a^A\lambda^{Ba}. \tag{14}$$

we have that:

$p^{AB} =$ 2.278e-24

$$p^{AB} = \varepsilon^{ab}\lambda_a^A\lambda_b^B = \lambda_a^A\lambda^{Ba} = \lambda_+^A\lambda_-^B - \lambda_-^A\lambda_+^B. \qquad (2)$$

and know that (see above):

$$q^{AI} = \lambda_a^A\eta^{Ia} \quad \text{and} \quad \tilde{q}_I^A = \lambda_a^A\frac{\partial}{\partial\eta_a^I} \quad I = 1, 2. \qquad (11)$$

We put q = 1.633

From

$$J_B = \prod_{i=1}^{n} p_i^{12}\left(\frac{p_{n-1}^{24}}{p_{n-1}^{12}} - \frac{p_n^{24}}{p_n^{12}}\right) \qquad (177)$$

we obtain, considering $p_{n-1}^m = \frac{1}{2}p^{AB}$:

(2.278e-24)^12 ((((((2.278e-24)/2)^24) / (((2.278e-24)/2)^12) - ((2.278e-24)^24) / ((2.278e-24)^12))))

Input interpretation:

$$(2.278\times10^{-24})^{12}\left(\frac{\left(\frac{2.278\times10^{-24}}{2}\right)^{24}}{\left(\frac{2.278\times10^{-24}}{2}\right)^{12}} - \frac{(2.278\times10^{-24})^{24}}{(2.278\times10^{-24})^{12}}\right)$$

Result:

$-3.812266317235931377050580930233626729774100473761 29\ldots\times10^{-568}$

-3.81226631723…*10^{-568}

From

$$J_F = \frac{1}{[\hat{\lambda}_{n-1\,\hat{a}}\hat{\lambda}^{\hat{a}}_{n}\;\hat{\lambda}_{n-1\,\hat{b}}\hat{\lambda}^{\hat{b}}_{n}]^2}\prod_{i=1}^{n-2}\left(\frac{1}{[\hat{\lambda}^2_i\,\hat{\lambda}^4_i]}\right)^2 \qquad (178)$$

we obtain, considering

$$p^{AB} = \varepsilon^{ab}\lambda^A_a\lambda^B_b = \lambda^A_a\lambda^{Ba} = \lambda^A_+\lambda^B_- - \lambda^A_-\lambda^B_+. \qquad (2)$$

$p^{AB} =$ 2.278e-24

1/((2.278e-24)^2)^2 * [1/((((2.278e-24)/2)^2 * ((2.278e-24)/2)^4))]^2

Input interpretation:

$$\frac{1}{((2.278\times 10^{-24})^2)^2}\left(\frac{1}{\left(\frac{2.278\times 10^{-24}}{2}\right)^2\left(\frac{2.278\times 10^{-24}}{2}\right)^4}\right)^2$$

Result:

$7.78933589512322858116564375895418876223564941147668 64\ldots \times 10^{381}$

7.78933589…*10^{381}

Comparison:

$\approx 9.5\times 10^{10}$ × Skewes number ($\approx 8.2\times 10^{370}$)

Thence, we obtain

$$A_4 = \delta^6\left(\sum_{i=1}^{4} p_i^{AB}\right)\delta^8\left(\sum_{i=1}^{4} q_i^{AI}\right)\times J_{4,B}J_{4,F}\times I_4\,. \qquad (79)$$

from all results and considering $1/10^m$, for m = 6, 8, 4, 4 and 4 and performing the inverse of the 4th root:

((((2.728e-24)*1/10^6 * 1.633*1/10^8 (7.789335895123e+381)*1/10^4 * (-3.812266317235e-568)*1/10^4 * (1.7008767751874126e-16)*1/10^4)))^(-1/4)

Input interpretation:

$$\left(2.728\times 10^{-24}\times\frac{1}{10^6}\times 1.633\times\frac{1}{10^8}\left((7.789335895123\times 10^{381})\times\frac{1}{10^4}\left(-\frac{3.812266317235}{10^{568}}\right)\times\frac{1}{10^4}\times 1.7008767751874126\times 10^{-16}\times\frac{1}{10^4}\right)\right)^{-1/4}$$

Result:

$3.24667...\times 10^{62}$ −

$3.24667...\times 10^{62}\ i$

Polar coordinates:

$r = 4.59149\times 10^{62}$ (radius), $\theta = -45°$ (angle)

(approximated form)

$A^{-1/4} = 4.591485673371*10^{62}$

Dividing this result by $1.220910*10^{19}$ and multiplying all by 1/2, we obtain:

1/2(4.591485673371*10^62 / 1.220910×10^19)

where 1.220910×10^{19} is the value of Planck mass in GeV

Input interpretation:

$$\frac{1}{2}\times\frac{4.591485673371\times 10^{62}}{1.220910\times 10^{19}}$$

Result:

$1.880353864480263999803425313905201857630783595842445 38...\times 10^{43}$

$1.880353864…*10^{43}$ value very near to the Planck frequency equal to 1.8549×10^{43} Hz

or, performing the following calculations:

1/golden ratio *sqrt(4.591485673371×10^62 *2.171312968239e+24)-(18+3-11)/10^2*10^43+3/10^3*10^43

where 3, 18 and 11 are Lucas numbers

Input interpretation:

$$\frac{1}{\phi}\sqrt{4.591485673371\times10^{62}\times2.171312968239\times10^{24}} - \frac{18+3-11}{10^2}\times10^{43}+\frac{3}{10^3}\times10^{43}$$

ϕ is the golden ratio

Result:

$1.85441747426...\times10^{43}$

$1.85441747426\ldots*10^{43}$ value practically equal to the Planck frequency

1.8549×10^{43} Hz

From

$$A_4 = \delta^6\left(\sum_{i=1}^{4} p_i^{AB}\right)\delta^8\left(\sum_{i=1}^{4} q_i^{AI}\right), \qquad (81)$$

we obtain:

(2.728e-24)*1/10^6 * 1.633*1/10^8

Input interpretation:

$$2.728\times10^{-24}\times\frac{1}{10^6}\times1.633\times\frac{1}{10^8}$$

Result:

4.454824×10^{-38}

$4.454824*10^{-38}$

and performing the following calculations:

(((2.728e-24)*1/10^6 * 1.633*1/10^8))^-1/4

Input interpretation:

$$\left(2.728\times10^{-24}\times\frac{1}{10^6}\times1.633\times\frac{1}{10^8}\right)^{-1/4}$$

Result:

$2.17667...\times10^{9}$

$2.17667\ldots*10^{9}$

From the ratio of the two results, we obtain:

a)

(4.591485673371*10^62 / 2.17667 × 10^9)

Input interpretation:

$$\frac{4.591485673371 \times 10^{62}}{2.17667 \times 10^{9}}$$

Result:

$2.109408258197613786196345794263714756945242044039748 7\ldots \times 10^{53}$

$2.10940825819\ldots*10^{53}$

b)

(2.17667 × 10^9 / 4.591485673371*10^62)

Input interpretation:

$$\frac{2.17667 \times 10^{9}}{4.591485673371 \times 10^{62}}$$

Result:

$4.74066599537469860590720105622954611975304281638158 58\ldots \times 10^{-54}$

$4.7406659953\ldots*10^{-54}$

From a), we obtain also:

0.88137(4.591485673371*10^62 / 2.17667 × 10^9)*1/10^10

where 0.88137 is a Hausdorff dimension equal to log(1+√2). Indeed:

ln(1+sqrt2)(4.591485673371*10^62 / 2.17667 × 10^9)*1/10^10

Input interpretation:

$$\log\left(1+\sqrt{2}\right) \times \frac{4.591485673371 \times 10^{62}}{2.17667 \times 10^{9}} \times \frac{1}{10^{10}}$$

$\log(x)$ is the natural logarithm

Result:

$1.85918\ldots \times 10^{43}$

$1.85918\ldots * 10^{43}$ value very near to the Planck frequency 1.8549×10^{43} Hz

Now, from

$$\mathcal{I}_{\mathrm{R}} = \int \frac{\prod_{m=0}^{d} d\rho^{1}_{m,-} d\rho^{2}_{m,-} d\rho^{3}_{m,+} d\rho^{4}_{m,+}}{\mathrm{Vol}(SL(2,\mathbb{C}))} dp_n^{12} dp_n^{34} \prod_{i=1}^{n-1} \delta\left(\frac{\rho_a^1(\sigma_i)\rho^{2a}(\sigma_i)}{P_i(\sigma)}\right) \delta\left(\frac{\rho_a^3(\sigma_i)\rho^{4a}(\sigma_i)}{P_i(\sigma)}\right)$$
$$\times \delta\left(p_n^{12} - \frac{\rho_a^1(\sigma_n)\rho^{2a}(\sigma_n)}{P_n(\sigma)}\right) \delta\left(p_n^{34} - \frac{\rho_a^3(\sigma_n)\rho^{4a}(\sigma_n)}{P_n(\sigma)}\right) \det{}' S_n\, U(\rho,\sigma)\,. \qquad (84)$$

For:

$$p^{AB} = \varepsilon^{ab}\lambda_a^A\lambda_b^B = \lambda_a^A\lambda^{Ba} = \lambda_+^A\lambda_-^B - \lambda_-^A\lambda_+^B. \qquad (2)$$

$p^{AB} =$ 2.278e-24

$p_{n-1}^{m} = \frac{1}{2}p^{AB}$: q = 1.633; for δ = 1

Det[{0, -1}, {1, 0}]]

$\rho_a^A(\sigma) = 24$ with $\rho_a^A = 4$; $\sigma = 6$ $P_i(\sigma) = 12$ with $P_i = 2$; $\sigma = 6$;

$$\chi_a^I(\sigma) = \sum_{m=0}^{d} \chi_{m,a}^I \sigma^m$$

= 48 = 8 * 6

Thence:

$$\int \frac{\prod_{m=0}^{d} d\rho^{1}_{m,-} d\rho^{2}_{m,-} d\rho^{3}_{m,+} d\rho^{4}_{m,+}}{\mathrm{Vol}(SL(2,\mathbb{C}))} dp_n^{12} dp_n^{34} \prod_{i=1}^{n-1} \delta\left(\frac{\rho_a^1(\sigma_i)\rho^{2a}(\sigma_i)}{P_i(\sigma)}\right) \delta\left(\frac{\rho_a^3(\sigma_i)\rho^{4a}(\sigma_i)}{P_i(\sigma)}\right)$$
$$\times \delta\left(p_n^{12} - \frac{\rho_a^1(\sigma_n)\rho^{2a}(\sigma_n)}{P_n(\sigma)}\right) \delta\left(p_n^{34} - \frac{\rho_a^3(\sigma_n)\rho^{4a}(\sigma_n)}{P_n(\sigma)}\right) \det{}' S_n\, U(\rho,\sigma)\,.$$

we obtain:

Integrate ((((1/(2.1713129682396 × 10^24) * (24*24^2)/12 * (24^3*24^4)/12 * ((((2.278e-24)^12-(24*24^2)/12))) * ((((2.278e-24)^34-(24^3*24^4)/12))) * Det[{0, -1}, {1, 0}]])))d^4 x

Input interpretation:

$$\left(\frac{1}{12}(24\times 24^2)\right)\left(\frac{1}{12}(24^3\times 24^4)\right)\left((2.278\times 10^{-24})^{12}-\frac{1}{12}(24\times 24^2)\right)\left((2.278\times 10^{-24})^{34}-\frac{1}{12}(24^3\times 24^4)\right)\begin{vmatrix}0 & -1\\ 1 & 0\end{vmatrix}$$

$|m|$ is the determinant

Result:

$1.9386519665512170494361600000000000000000000000000\ldots\times 10^{23}$

$1.9386519665512170494361600000000000000000000000000\ldots\times 10^{23}$

1.9386519665512170494361600000000000000000000000000…*10^23

integrate(1.9386519665 × 10^23)d^4x

Indefinite integral:

$$\int 1.9386519665\times 10^{23}\, d^4x\, dx = 9.693259833\times 10^{22}\, d^4x^2 + \text{constant}$$

9.693259833*10^22 x^2

we have also:

1/(2.1713129682396 × 10^24) and σ = x = 6, thence:

1/(2.1713129682396 × 10^24) * 9.693259832×10^22 * 6^2

Input interpretation:

$$\frac{1}{2.1713129682396\times 10^{24}}\times 9.693259832\times 10^{22}\times 6^2$$

Result:

1.607126006505264241963178238442512030384177265006760244847…

1.6071260065…..

From which:

(((1/(2.1713129682396 × 10^24) * 9.693259832×10^22 * 6^2)))+11/10^3

where 11 is a Lucas number

Input interpretation:

$$\frac{1}{2.1713129682396 \times 10^{24}} \times 9.693259832 \times 10^{22} \times 6^2 + \frac{11}{10^3}$$

Result:

1.6181260065052642419631782384425120303841772650067602448 47...

Input interpretation:

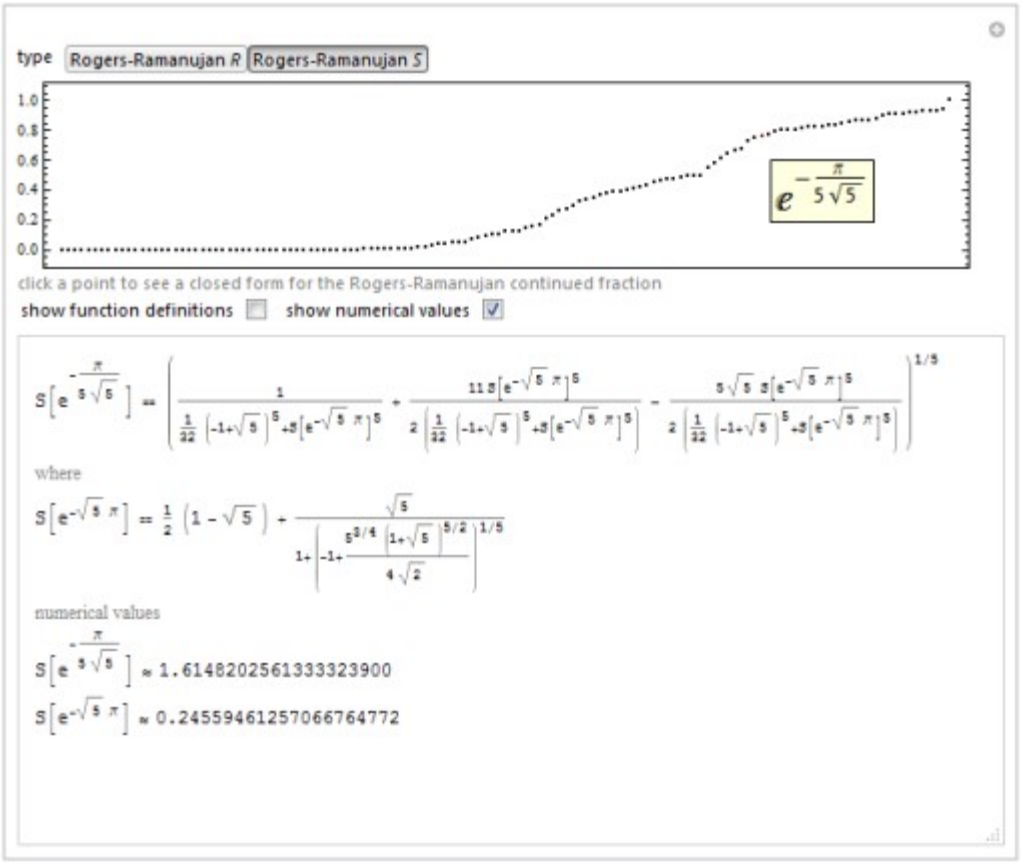
1.61812

1.61812 result that is a very good approximation to the value of the golden ratio 1.618033988749...

Ramanujan formula to obtain a precise value of Golden Ratio

From:

https://blog.wolfram.com/2013/05/01/after-100-years-ramanujan-gap-filled/



1/(((1/32(-1+sqrt(5))^5+5*(e^((-sqrt(5)*Pi))^5)))

Input:

$$\frac{1}{\frac{1}{32}\left(-1+\sqrt{5}\right)^5+5\,e^{\left(-\sqrt{5}\,\pi\right)^5}}$$

Exact result:

$$\frac{1}{\frac{1}{32}\left(\sqrt{5}-1\right)^5+5\,e^{-25\sqrt{5}\,\pi^5}}$$

Decimal approximation:

11.090169943749474241022934171828190588601545899028814310 67...

11.090169943749…

(11*5*(e^((-sqrt(5)*Pi))^5))) / (((2*(((1/32(-1+sqrt(5))^5+5*(e^((-sqrt(5)*Pi))^5)))

Input:

$$\frac{11\times 5\, e^{\left(-\sqrt{5}\,\pi\right)^5}}{2\left(\frac{1}{32}\left(-1+\sqrt{5}\right)^5+5\, e^{\left(-\sqrt{5}\,\pi\right)^5}\right)}$$

Exact result:

$$\frac{55\, e^{-25\sqrt{5}\,\pi^5}}{2\left(\frac{1}{32}\left(\sqrt{5}-1\right)^5+5\, e^{-25\sqrt{5}\,\pi^5}\right)}$$

Decimal approximation:

$9.9929022507071872307053630412945712274243697626525 5\ldots \times 10^{-7428}$

$9.9929022507\ldots *10^{-7428}$

(5sqrt(5)*5*(e^((-sqrt(5)*Pi))^5))) / (((2*(((1/32(-1+sqrt(5))^5+5*(e^((-sqrt(5)*Pi))^5)))

Input:

$$\frac{5\sqrt{5}\times 5\, e^{\left(-\sqrt{5}\,\pi\right)^5}}{2\left(\frac{1}{32}\left(-1+\sqrt{5}\right)^5+5\, e^{\left(-\sqrt{5}\,\pi\right)^5}\right)}$$

Exact result:

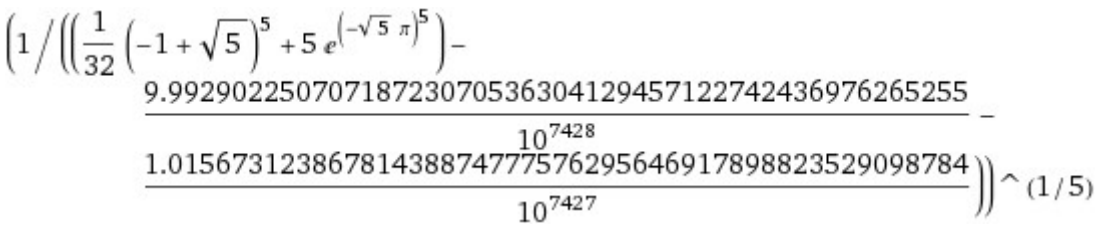
$$\frac{25\sqrt{5}\, e^{-25\sqrt{5}\,\pi^5}}{2\left(\frac{1}{32}\left(\sqrt{5}-1\right)^5+5\, e^{-25\sqrt{5}\,\pi^5}\right)}$$

Decimal approximation:

$1.0156731238678143887477757629564691789882352909878 4\ldots \times 10^{-7427}$

$1.0156731238\ldots *10^{-7427}$

Input interpretation:



(((((1/(((1/32(-1+sqrt(5))^5+5*(e^((-sqrt(5)*Pi))^5)))-(9.9929022507071872307053630412945712274243697626525 5 × 10^-7428) -(1.015673123867814388747775762956469178988235290987 84 × 10^-7427))))))^1/5

Result:

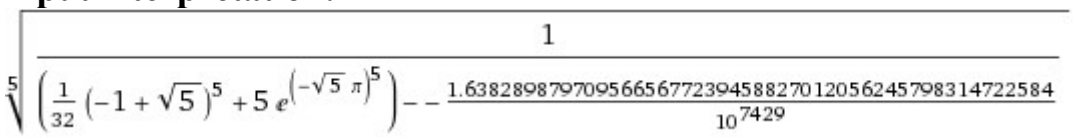
1.6180339887498948482045868343656381177203091798057628 62135...

1.6180339887…. = ϕ

or:

((((1/(((1/32(-1+sqrt(5))^5+5*(e^((-sqrt(5)*Pi))^5)))-(-1.6382898797095665677239458827012056245798314722584 × 10^-7429)))^1/5

Input interpretation:



Result:

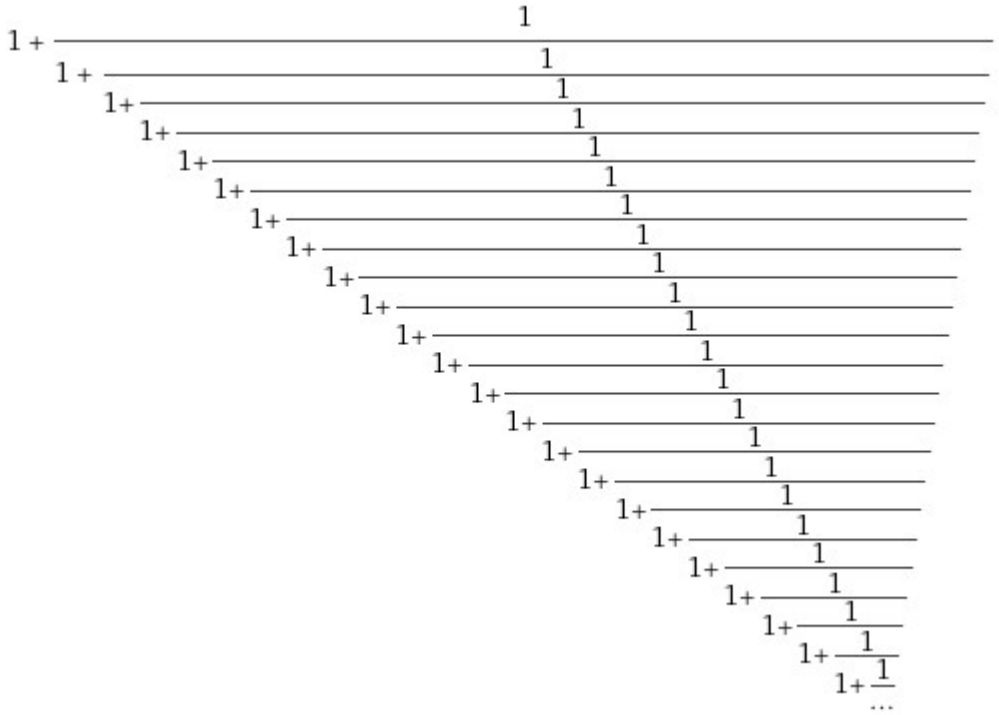
1.6180339887498948482045868343656381177203091798057628 62135...

The result, thence, is:

1.6180339887498948482045868343656381177203091798057628

This is the wonderful golden ratio, fundamental constant of various fields of mathematics and physics and which we have dealt widely with, obtaining various good approximations, in this paper

Continued fraction:



Possible closed forms:

$\phi \approx 1.6180339887498948482045868343656381177203091798057628\,62135$

$\Phi + 1 \approx 1.6180339887498948482045868343656381177203091798057628\,62135$

$\frac{1}{\Phi} \approx 1.6180339887498948482045868343656381177203091798057628\,62135$

Possible closed forms:

$\phi \approx 1.618\,03398$

$-\frac{25\,M}{27} \approx 1.618\,15365$

$\frac{500}{309} \approx 1.618\,129773$

$\sqrt{5}\ c_{\text{Sa}} \approx 1.618\,170193$

$\Phi + 1 \approx 1.61803398$

ϕ is the golden ratio

M is the Madelung constant

C_{Sa} is the Sarnak constant

Φ is the golden ratio conjugate

Observations

All the results of the most important connections are signed in blue throughout the drafting of the paper. We highlight as in the development of the various equations we use always the constants π, ϕ, 1/ϕ, the Fibonacci and Lucas numbers, linked to the golden ratio, that play a fundamental role in the development, and therefore, in the final results of the analyzed expressions.

In mathematics, the Fibonacci numbers, commonly denoted F_n, form a sequence, called the Fibonacci sequence, such that each number is the sum of the two preceding ones, starting from 0 and 1. Fibonacci numbers are strongly related to the golden ratio: Binet's formula expresses the nth Fibonacci number in terms of n and the golden ratio, and implies that the ratio of two consecutive Fibonacci numbers tends to the golden ratio as n increases.
Fibonacci numbers are also closely related to Lucas numbers ,in that the Fibonacci and Lucas numbers form a complementary pair of Lucas sequences

The beginning of the sequence is thus:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987, 1597, 2584, 4181, 6765, 10946, 17711, 28657, 46368, 75025, 121393, 196418, 317811, 514229, 832040, 1346269, 2178309, 3524578, 5702887, 9227465, 14930352, 24157817, 39088169, 63245986, 102334155...

The Lucas numbers or Lucas series are an integer sequence named after the mathematician François Édouard Anatole Lucas (1842–91), who studied both that sequence and the closely related Fibonacci numbers. Lucas numbers and Fibonacci numbers form complementary instances of Lucas sequences.

The Lucas sequence has the same recursive relationship as the Fibonacci sequence, where each term is the sum of the two previous terms, but with different starting values. This produces a sequence where the ratios of successive terms approach the golden ratio, and in fact the terms themselves are roundings of integer powers of the golden ratio.[1] The sequence also has a variety of relationships with the Fibonacci numbers, like the fact that adding any two Fibonacci numbers two terms apart in the Fibonacci sequence results in the Lucas number in between.

The sequence of Lucas numbers is:

2, 1, 3, 4, 7, 11, 18, 29, 47, 76, 123, 199, 322, 521, 843, 1364, 2207, 3571, 5778, 9349, 15127, 24476, 39603, 64079, 103682, 167761, 271443, 439204, 710647, 1149851, 1860498, 3010349, 4870847, 7881196, 12752043, 20633239, 33385282, 54018521, 87403803……

All Fibonacci-like integer sequences appear in shifted form as a row of the Wythoff array; the Fibonacci sequence itself is the first row and the Lucas sequence is the second row. Also like all Fibonacci-like integer sequences, the ratio between two consecutive Lucas numbers converges to the golden ratio.

A Lucas prime is a Lucas number that is prime. The first few Lucas primes are:

2, 3, 7, 11, 29, 47, 199, 521, 2207, 3571, 9349, 3010349, 54018521, 370248451, 6643838879, ... (sequence A005479 in the OEIS).

In geometry, a golden spiral is a logarithmic spiral whose growth factor is φ, the golden ratio.[1] That is, a golden spiral gets wider (or further from its origin) by a factor of φ for every quarter turn it makes. Approximate logarithmic spirals can occur in nature, for example the arms of spiral galaxies[3] - golden spirals are one special case of these logarithmic spirals

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