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The 22 Letters of Reality: Chiral Bisedenion Properties for Maximal Information Propagation

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Abstract

Unit norm multiplicative propagation is possible beyond the level of octonions, into a 10-dimensional subspace of the bi-sedenions (where the first six Cayley algebras go as: real, complex, quaternion, octonion, sedenion, trigintaduonion aka bi-sedenion). The resultant, strictly unitary, propagation in 10-dim is more recently found to be extendable to a perturbatively stable unitary propagation if the perturbation amplitude is at most alpha (the fine-structure constant). Thus, the prior exploration also provides a computational/theoretical framework for derivation of alpha via the maximum perturbation limit for chiral trigintaduonion propagation. In this work we look at the propagation of 'maximal information', where we work with multiplicative bi-sedenion algebraic evolution when each multiplicative 'step' involves a unit-norm chiral bisedenion with perturbation contribution allowed in the nearby general bi-sedenion algebra up to the maximal magnitude of alpha. An analysis of alpha-propagation (where the amplitude is strictly at alpha) with perturbation concentrated in each of the 22 non-propagating dimensions is done. Results are shown for the resulting 22 emergent parameters, or "letters" of reality.

Keywords: Path Integral, Generalized Propagator; Cayley Algebra; 22 letters; 137

1 Introduction

It has long been a mystery as to why so many languages, both man-made and natural, should have arrived at language encoding schemes involving 22 letters (or 22 emergent parameters, such as for the Standard Model with νMSM extension). In this paper further work with bi-sedenions is shown that builds on prior work [1, 2], and it is explained why 22-letter schemes are actually optimal. Furthermore, when working with the 'optimal' 22-letter encoding schemes, there anomalously appears the number '137' across all such schemes as a key parameter (in physics) or scoring (in Babylonian/Hebrew gematria encoding [3], itself an elaborate bi-sedenion optimization). The occurrence of '137' is now explained as a simple feature of the bi-sedenion maximal information propagation described in [2].

The Feynman-Cayley Path Integral proposed in [1, 2] involved use of chiral bi-sedenions in an effort to identify a mathematical framework within which to have a unified propagator theory (and maximal information propagation was sought for such a hypothesized propagator). At its root, this is a hypothesis for an algebraic reality, with algebraic elements describing 'reality' and algebraic multiplicative processes underlying propagation. All of the different 'paths' of propagation are then brought together in a sum – where stationary phase is selected out and the variational calculus basis for much of physics then takes over to offer all of the familiar elegant solutions of classical physics.

When speaking of 'propagation' for the algebra we mean preservation of unit norm with each multiplicative operation underlying the propagation steps. Recall that the classic definition for the normed division algebras is that $N(xy)=N(x)N(y)$, where unit norm propagation is possible (Hurwitz's theorem) for multiplication by a unit norm member of the normed division algebras: real, complex, quaternion, and octonion algebras. The higher Cayley algebras (sedenion, bi-sedenion, and beyond) then fail to have a norm for the higher Cayley algebras, particularly the next two Cayley algebras in the hierarchy. In [1] it was shown how one-dimensional chiral extensions were possible into the sedenion algebra, and again into the bi-sedenion algebra, but then no further. Previously efforts to embed the standard model of physics were restricted, if propagation of unit norm was desirable, to a standard octonion with its eight components (minus one free component due to unit norm constraint, giving rise to an element of S7). Using the aforementioned chiral extensions, a larger space of viable propagators is possible [1], that offers more 'room' to accommodate the standard model, and that also has natural chiral properties, as already observed in the standard model.

In this paper we will begin with the theoretical expression for a general element of the bi-sedenion algebra after two chiral bi-sedenion multiplicative propagation steps. A simple analysis of the number of terms in this expression, when reduced to three-element algebraic 'braid-level', results in a count on algebraic braids of 137, plus a little extra (e.g. some lagniappe for the best 'cooking') of a contribution towards a 138th braid, that involves a complex-dimensional extension outside the 10-dim propagation. Further work is then done, computationally, to determine the 22 parameters that emerge. A theoretical/computational discussion for why parameters should emerge, and do so in a stable manner, is given as well.

2 Background on Cayley Algebras

I reproduce here the very brief background on Cayley algebras from [1], much more extensive background can be found at [4].
The list representation for hypercomplex numbers will make things clearer in what follows so will be introduced here for the first seven Cayley algebras:

Reals: $X_0 \rightarrow (X_0)$.
Complex: $(X_0 + X_1 \boldsymbol{i}) \rightarrow (X_0, X_1)$.
Quaternions: $(X_0 + X_1 \boldsymbol{i} + X_2 \boldsymbol{j} + X_3 \boldsymbol{k}) \rightarrow (X_0, X_1, X_2, X_3) \rightarrow (X_0, \ldots, X_3)$.
Octonions: $(X_0, \ldots, X_7)$ with seven imaginary numbers.
Sedenions: $(X_0, \ldots, X_{15})$ with fifteen imaginary numbers.
Trigintaduonions (a.k.a Bi-Sedenions): $(X_0, \ldots, X_{31})$ with 31 imaginary numbers.
Bi-Trigintaduonions: $(X_0, \ldots, X_{63})$ with 63 types of imaginary number.

Consider how the familiar complex numbers can be generated from two real numbers with the introduction of a single imaginary number '$\boldsymbol{i}$', $\{X_0, X_1\} \rightarrow (X_0 + X_1 \boldsymbol{i})$. This construction process can be iterated, using two complex numbers, $\{Z_0, Z_1\}$, and a new imaginary number '$\boldsymbol{j}$':

$$(Z_0 + Z_1 \boldsymbol{j}) = (A+B\boldsymbol{i}) + (C+D\boldsymbol{i})\boldsymbol{j} = A+B\boldsymbol{i} + C\boldsymbol{j} + D\boldsymbol{ij} = A+B\boldsymbol{i} + C\boldsymbol{j} + D\boldsymbol{k},$$

where we have introduced a third imaginary number '$\boldsymbol{k}$' where '$\boldsymbol{ij}=\boldsymbol{k}$'. In list notation this appears as the simple rule ((A,B),(C,D)) = (A,B,C,D). This iterative construction process can be repeated, generating algebras doubling in dimensionality at each iteration, to generate the 1, 2, 4, 8, 16, 32, and 64 dimensional algebras listed above. The process continues indefinitely to higher orders beyond that, doubling in dimension at each iteration, but we will see that the main algebras of interest for physics are those with dimension 1, 2, 4, and 8, and sub-spaces of those with dimension 16 and 32 dimensional algebras.
Addition of hypercomplex numbers is done component-wise, so is straightforward. For hypercomplex multiplication, list notation makes the freedom for group splittings more apparent, where any hypercomplex product ZxQ to be expressed as (U,V)x(R,S) by splitting Z=(U,V) and Q=(R,S). This is important

because the product rule, generalized by Cayley, uses the splitting capability. The Cayley algebra multiplication rule is:

(A,B)(C,D) = ([AC–D*B],[BC*+DA]),

where conjugation of a hypercomplex number flips the signs of all of its imaginary components:

(A,B)* = Conj(A,B) = (A*,–B)

The specification of new algebras, with addition and multiplication rules as indicated by the constructive process above, is known as the Cayley-Dickson construction, and this gives rise to what is referred to as the Cayley algebras in what follows.

The key software solution to discover/verify the results computationally is the recursive Cayley definition for multiplication, which avoids use of lookup tables and avoids commutation and associativity issues encountered at higher order. It is shown in the Methods. Further details on Cayley algebras, and the Sedenions and Bi-Sedenions in particular, are given in [1, 4].

3 Methods

The Cayley subroutine takes the references to any pair of Cayley numbers (represented in list form, so represented as simple arrays), and multiplies those Cayley numbers and returns the Cayley number answer (in list form, thus an array). The main usage was with randomly generated unit norm Cayley numbers that were multiplied (from right) against a "running product". Tests on unit norm hold for millions of running product evaluations in cases where the unit norm propagations are validated (running like the perfectly meshed gears of a machine, or the perfectly 'braided' threads of a very long string).

The bignum module was used with 50 decimal places of precision in most experiments, with some experiments at 100 decimal places of precision in further validation testing. Using bignum allows much higher precision handling (needed for the iterative processes of repeated multiplicative updates). The use of bignum, however, entails number representation/storage via strings and is vastly slower than normal arithmetic operations. Furthermore, modern GPU enhancements are not possible with the string handling intermediaries, so the resultant computational threads are CPU intensive and slow.

---------------------------------- cayley_multiplication.pl --
-

```
# using bignum

sub cayley {
    my ($ref1,$ref2)=@_;
    my @input1=@{$ref1};
    my @input2=@{$ref2};
    my $order1=scalar(@input1);
    my $order2=scalar(@input2);
    my @output;
    if ($order1 != $order2) {die;}
    if ($order1 == 1) {
        $output[0]=$input1[0]*$input2[0];
    }
    else{
        my @A=@input1[0..$order1/2-1];
        my @B=@input1[$order1/2..$order1-1];
        my @C=@input2[0..$order1/2-1];
        my @D=@input2[$order1/2..$order1-1];
        my @conjD=conj(\@D);
        my @conjC=conj(\@C);
        my @cay1 = cayley(\@A,\@C);
        my @cay2 = cayley(\@conjD,\@B);
        my @cay3 = cayley(\@D,\@A);
        my @cay4 = cayley(\@B,\@conjC);
        my @left;
        my @right;
        my $length = scalar(@cay1);
        my $index;
        for $index (0..$length-1) {
            $left[$index] = $cay1[$index] - $cay2[$index];
            $right[$index] = $cay3[$index] + $cay4[$index];
        }
        @output=(@left,@right);
    }
    return @output;
}
```

---------------------------------- cayley_multiplication.pl --
-

Unit-norm multiplicative 'step' generation method (same as used in [2])
The randomly generated propagation step is for a unit norm that has a randomly generated small perturbation. Consider the eight element octonion denoted: $\{\Delta x_0, \delta x_1, \delta x_2, \ldots \delta x_7\}$, where the real component is $\Delta x_0 \approx 1$:
$$(\Delta x_0)^2 = 1 - \Sigma\, (\delta x_i)^2 \,,$$

And where each δx_i is generated by a randomly generated number uniformly distributed on the interval (-0.5 .. 0.5), with an additional perturbation-factor '**δ**', e.g., the max magnitude imaginary perturbation from pure real (**Δx_0=1)**, measured with L_1 norm, is simply 7 times $\delta/2$ (for seven imaginary components).

For the octonions unrestricted unit norm propagation is possible, i.e., all of the components can be independently generated and then normalized to have L_2 norm =1. So, the restriction to **$\Delta x_0 \approx 1$** isn't needed. The same is true on the (left) chiral extension spaces:

Propagating chiral left sedenion: $\{\Delta x_0, \delta x_1, \delta x_2, \ldots \delta x_7, \delta x_8\}$, with $\delta x_9=0, \ldots, \delta x_{15}=0$,

and the

Propagating chiral left bi-sedenion: $\{\Delta x_0, \delta x_1, \delta x_2, \ldots \delta x_7, \delta x_8, \delta x_{16}\}$, with $\delta x_9=0, \ldots, \delta x_{15}=0, \delta x_{17}=0, \ldots, \delta x_{31}=0$.

Consider now the propagating chiral left bi-sedenion with the a small non-propagating component (here **δx_9** nonzero is chosen), and now let's return to formally requiring **$\Delta x_0 \approx 1$** on propagation steps:

Propagating small perturbation chiral left bi-sedenion: $\{\Delta x_0, \delta x_1, \delta x_2, \ldots \delta x_7, \delta x_8, \boldsymbol{\delta x_9}, \delta x_{16}\}$, with $\delta x_{10}=0, \ldots, \delta x_{15}=0, \delta x_{17}=0, \ldots, \delta x_{31}=0$.

For the small perturbation steps that are randomly generated, there are now ten imaginary components, so in what follows, the maximum magnitude of the imaginary components, measured with L_1 norm, denoted **Δ,** is **Δ=**$10\delta/2=5\delta$.

4 Results

4.1 Theoretical

Consider a general norm=1 bisedenion in list notation: (A,B), where A and B are sedenions. Consider a propagator bisedenion (C,β), $C = (c,\alpha)$, where c is an octonion and α is shorthand for the real octonion $(\alpha,0,0,0,0,0,0,0)$, where α is a real number, and β is shorthand for the real sedenion $(\beta,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0)$, where β is a real number. Using A=(a,b), B=(u,v), and the multiplication rule from Sec. 2, we have:

$(A,B)(C,\beta) = ([AC-\beta^*B], [BC^*+\beta A])$, where

$AC = (a,b)(c,\alpha) = ([ac-\alpha^*b],[bc^*+\alpha a])$; $BC^*=(u,v)(c^*,-\alpha) = ([uc^*+\alpha^*v],[vc^*-\alpha u])$.

Thus, we have:

$(A,B)(C,\beta) = ([(ac-\alpha^*b , bc^*+\alpha a)-\beta^*(u,v)] , [(uc^*+\alpha^*v , vc-\alpha u)+\beta(a,b)])$, so,

$(A,B)(C,\beta) = ([ac-\alpha^*b-\beta^*u\ ,\ bc^*+\alpha a-\beta^*v]\ ,\ [uc^*+\alpha^*v+\beta a\ ,\ vc-\alpha u+\beta b])$.
Now consider another propagator bisedenion (C',β'), $C' = (c',\alpha')$, and form the product corresponding to the next multiplicative step:

$((A,B)(C,\beta))\ (C',\beta') = (\ [(ac)c' - \alpha^*bc' - \beta^*uc' - \alpha'^*(bc^*+\alpha a-\beta^*v)\ ,\ \ldots]\ ,\ [\ldots\ ,\ \ldots]\ )$, where only the first expression at octonionic level is shown. Notice how the expression is comprised of terms with three octonionic factors. In [1] are described the 'braid laws' for multiplication involving three octonions, which can be used here to uniquely order any octonion product with an ordering simply corresponding to their list order.
Returning to the first product expression at octonionic level:
$(ac)c' - \alpha^*bc' - \beta^*uc' - \alpha'^*(bc^*+\alpha a-\beta^*v)$.

Notice how the first three terms involve c', the octonionic part from the latest propagation, while the next three terms do not, only involving the chiral sedenion part from the latest propagation step. The term $\alpha'^*\beta^*v$ contributes to the collection of terms with c', to complete a set of 10-choose-3 braids (after reordering to list order using the braid rules), giving rise to 10x9x8/3x2 = 120 terms, or independent 'braids' of algebraic information transmission. The $\alpha'^*\beta^*v$ term also gives rise to an independent term when further propagations are considered (than the last two), where, for example, there is a term $\alpha'^*(\beta^*)^n v$ from which results 8 independent braid terms traceable to 'v'. Similarly, the $\alpha'^*\alpha a$ term is part of a more general 'telescoping' on α chiral terms: $\alpha'^*(\alpha)^n a$, where again, 8 independent braid terms result traceable to 'a'. The term $\alpha'^*\alpha a$ shows how original information at the octonionic level is transmitted via two, purely real, chiral sedenions, bounded to have unit norm at most. The 'a' octonion is arbitrary, involving eight independent octonion parameters, thus eight possible terms. The same description holds for the expansion (with more propagation multiplications) of the $\alpha'^*\beta^*v$ term, except now we see the beginning of mixing on the real octonions from the sedenion and bisedenion levels, but bounded with norm less than one, and with another eight information transmission 'braids'.

All of the octonion products involve octonions with norms at most unity, and by the normed division algebra rules on octonions, their norm is simply the norm of the individual octonions multiplied together, all of which are bounded by unity, thus their product is bounded by unity. The overall bound for the expression, each individual term being bounded by unity, is therefore simply the counting on the independent terms. This brings the total number of independent terms, each bounded by one, to 136, with one term left to be addressed.

The last term to be addressed is α'^*bc^*. The term describes the first bisedenion's 'b' octonion component multiplied by the first propagator bisedenions 'c*' octonion, followed by the last propagation with a real octonion (from the chiral sedenion). The generation of more terms, in general, with repeated propagation steps, and eventually repeated multiplication on octonions, is expected to select out the real octonion in this term. The 'bc*' octonion product can be viewed as the first of a lengthy chain product of octonions as more multiplicative steps are made, e.g., the last term generalizes (with more propagation multiplication steps) to include terms like: $\alpha'^*b(c^*)^n$. Just like a multiplication involving a random collection of unit norm complex numbers (motions on S1) will result in cancellation of the complex components only leaving the real part, the same hold true for multiplications of unit norm octonions (corresponding to motions on S7), with cancelation down to a real octonion, giving rise to one more, real, term to bring the total to 137 independent braid channels. The problem with this last analysis, however, is that the octonions don't have unit norm (they are bounded by unit norm, and the bi-sedenion of which they are part has unit norm), although they do have an approximately unit norm. So what results is a 137th channel from the added real channel already indicated, but there is also a non-real remnant (giving rise to a fraction of an additional channel). In other words, the maximum magnitude of the real component of the octonion in the product term is given with a 'channel multiplier' of 137. In seeking the maximum information propagation, we require that the real component never cross zero, thus the strictest condition on evaluating evolution is when the imaginary components have real component contribution that is antiphase, e.g., the imaginary angle is π, such that the real component contribution is $\cos(\pi) = -1$, bringing the real component closer to the zero crossing. We would limit the maximum perturbation allowable by this worst case. Other cases of complex phase $n\pi$, n odd, are possible to get the maximal real limitation, but give rise to less strict constraint on the perturbation limit, thus singling out the cumulative complex angle to be π.

If the magnitude is 137, and the (cumulative) imaginary component is π, then the real component of the octonion (containing the real part of the propagation bi-sedenion) is simply: $137 \cos(\pi/137)$. This gives us an estimate of the 'channel multiplier' mentioned previously, but requires rescaling to be properly normalized in the full bisedenion space. When arriving at the 'cumulative' imaginary phase, of π, there were 29 achiral imaginary component that were free to contribute, uniformly, each with the phase angle π/29. Their L1 phase addition then gave rise to the 'π' cumulative phase used thus far. In the non-normalized magnitude evaluation, the 29 achiral components would be described as having imaginary magnitude π/29 and real magnitude 137, with complex angle π/(137*29), thus real component is [π/(137*29)]cos([π/(137*29)]). When in the renormalized setting, however, we expect the real component to be sin([π/(137*29)]). So the channel multiplier upon rescaling is:

$$M = 137 \cos(\pi/137) \{ \sin(\pi/(137*29)) / [\pi/(137*29)\cos(\pi/(137*29))] \},$$

Or, using the notation tanc(x) = tan(x)/x, this becomes:

$$M = 137 \cos(\pi/137)\, \mathrm{tanc}(\pi/(137*29)).$$

So, the worst-case channel multiplier, M, times the maximum perturbation allowed, must be less than 1, to prevent breaking the norm<1 bounds and real-component zero-crossing. Thus, the maximum perturbation, alpha, allowed is alpha*M=1, thus,

$1/\text{alpha} = 137 \cos(\pi/137)\, \mathrm{tanc}(\pi/(137*29)) = 137.035999786699.$

This theoretical expression for the fine-structure constant first appeared in Gilson [10], but it wasn't clear in that effort why the number '29' should appear, nor the origin of the trig terms. In this derivation of the expression, we see that the number 29, etc., simply results from the number of achiral imaginary components (that are unconstrained, unlike the two chiral imaginary components) in the trigintaduonions.

To recap, in the perturbative setting, each of the terms at lowest order would involve one perturbation parameter factor, and would be bounded by the 137 (plus a fraction) terms involved times the amount of the maximum perturbation allowed. We want the starting 'general' bi-sedenion, and any subsequent bi-sedenion resulting from stepwise multiplicative propagation, to have total perturbation less than 1:

(perturbation) x 137.03599 < 1, thus maximum perturbation is at 1/137.035999.

At this juncture, therefore, we have a theoretical explanation for the alpha parameter shown that was derived computationally in [2].

In computational experiments in the next subsection, building on the results from [2], the emergent parameters of the theory are determined. In the 32 dim bi-sedenion space, where chiral propagation was in only 10 of those dimensions, the other 22 dimensions give rise to 22 emergent parameters (or ‘letters’), and this is what is shown in the next section. Before doing this, however, further theoretical description is needed for the 22 types of perturbations considered in the datarun results.

Consider an “on-shell” propagator bisedenion as before (C,β), $C = (c,\alpha)$, where c is an octonion and α is shorthand for the real octonion $(\alpha,0,0,0,0,0,0,0)$, where α is a real number. Now consider a bisedenion propagator perturbed “off-shell” (norm = 1, but have non-zero component outside the 10 dim chiral bised sub-algebra): (C_δ,β'), $C_\delta = (c',(\alpha',\delta))$, where (α',δ) is shorthand for $(\alpha',0,0,0,\delta,0,0,0)$, which is described as the δx_{12} perturbation case in Sec. 3. The δx_9 perturbation case in Sec. 3 would be $(\alpha',\delta,0,0,0,0,0,0)$, for which computational results are shown in the next section. Further theoretical derivation is done for the δx_{12} perturbation case in the next few expressions since it’s easiest to work with using the Cayley multiplication rules:

$(C,\beta)(C_\delta,\beta') = ([cc' - (\alpha',\delta)^*\alpha-\beta'^*\beta , \alpha c'^*+(\alpha',\delta)c] , [\beta c'+\beta' c , \beta'\alpha-\beta(\alpha',\delta)])$,

where

the added terms with component-level perturbation involve the δ terms above. Consider the first term with δ:

$(\alpha',\delta)^*\alpha = (\alpha'^*,-\delta)\alpha = (\alpha'^*,-\delta)(\alpha,0) = (\alpha'^*\alpha , -\delta\alpha^*)$, where α’s shift from real octonionic to real quaternionic. A different ‘noise injection’ than at parameter x_{12} would project out a different portion of the propagation.

4.2 Computational

In the tables that follow are shown the emergent parameters when alpha-perturbations (perturbations with max perturbation alpha) are injected for each of the 22 non-propagating parameters. Regardless of injection parameter, if perturbation exceeds alpha, the norm=1 relation fails, and propagation eventually dies with norm ≈ 0. This is to be expected given the identification of alpha as the max-perturbation limit in [2]. What is odd is that if perturbation is less than alpha, but still in the vicinity of alpha, norm=1 behavior appears to eventually fail (after millions of iterations, and using bignum precision) as can be seen in the real component eventually falling to zero. In other words, the iterative procedure underlying the propagator definition, not surprisingly, is giving rise to fractal behavior (and abrupt transitions). I say not surprisingly because the single parameter noise injection that we are using (in repeated multiplicative iterations) is such that we’ve set up an iterative process with a 1-dim parameter space and are seeing possible fractal behavior -- a well-known phenomenon in 1-D complex systems. Thus, the results that follow are *preliminary estimates* on the ‘letters of reality’ (actually numbers in this numerogenesis algebraic theory) in that both the noise injection method can lead to artifacts, and due to the slow process of doing bi-sedenion multiplication with bignum(50).

In the experiments tabulated in what follows we consider unit norm chiral bi-sedenion propagation. In particular, we consider unit element chiral bisedenion propagations, with alpha perturbations introduced, separately, at each of the non-propagating bi-sedenion parameters. If working with a perturbation greater than alpha we expect the real component to start at one (we begin with a unit element chiral bisedenion) and eventually decay to zero, and cross-over to negative values, as it begins to randomly walk. To a lesser extent, and with fractal structure, this also appears to be true for perturbations introduced that are in the vicinity of alpha but less than alpha. For perturbations precisely at ‘alpha’, we expect the real component to decay/search for a while, but to then asymptote/lock-on to a particular non-zero (emergent) value with well-defined variance about that asymptote, and never crossing zero. In other words, if we want to propagate one bit of information via the real component asymptote of the bi-sedenion indefinitely, it is hypothesized that we can do so using alpha perturbation propagators. In Fig. 1 is shown the Histogram on real components (rc) observations after each multiplicative iteration, where an emergent rc=0.971 appears in the first 60,000 propagation iterations.

To recap, for ‘off-shell’ bi-sedenion propagation at maximum perturbation amplitude alpha, we examine the behavior of the real component (rc) of the bi-sedenion. This is because we are effectively describing propagation starting with a unit bi-sedenion (so only have rc=1 nonzero), followed by multiplicative propagation steps by way of bisedenions perturbed by at most the fraction alpha into the bisedenions 31 imaginary components. As described in Sec. 4.1, we consider each of the 22 possible non-propagating parameters in separate perturbation-at-alpha analyses, where the emergent behavior on the rc value is obtained. For the ‘alpha propagation’, where noise injection is solely in a particular non-propagating component, we expect the rc component to decay but to eventually asymptote to a positive value (and never cross zero). The Results in Table 1 show the emergent 22 parameters when propagation is done with precisely alpha perturbation, where alpha is taken to be the highest precision value known provided by QED (1/137.035999070) [5, 6] (which appears via δ=0.001459470514006 in the code).

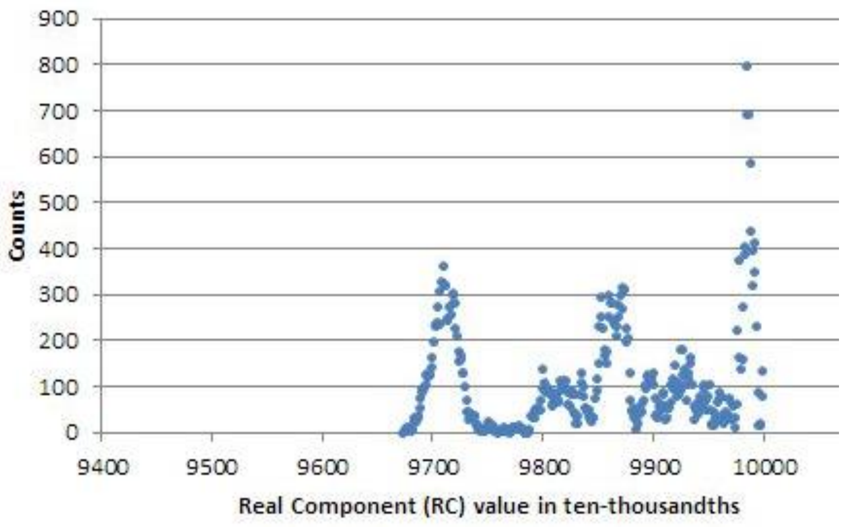

Fig. 1. Histogram of real-component values observed in the first 60,000 iterations of alpha propagation, where the perturbation parameter is δx_{30}. As the propagation begins the RC value is at 1.0=10,000/10,000, so at the rightmost dot in the histogram. As the multiplicative operations proceed, the rc value decays thru the range to rc =0.9750, then begins to catch the asymptote with mean at 0.9710.

The alpha propagations are examined for each of the 22 different non-propagating components, with each taken individually as sole source of non-propagating perturbation in its respective alpha propagation experiment. Since this process is selecting propagators somewhat arbitrarily, perhaps not as much utility can be extracted from the asymptotic RC values as from their *variance* information. In other words, by injecting noise perturbations into each of the 22 parameters separately (like playing a recorder with only one hole depressed at a time), computational experiments are attempting to arrive at information respective to 22 parameters, but may do so in a mixed form not so useful when expressed in the RC values. Furthermore, the Gaussian distributions that appear to be emergent at the asymptotes have variance values (or their inverses as shown in Table 1) that may provide the most utility. In essence the variance can be thought of as describing a statistical restoring force that's occurring in the bi-sedenion propagation due to the odd properties of bisedenion in general, e.g., they are: non-associative, non-commutative, have zero-divisors, and lack of inverse due to lack of norm. Bisedenion properties are not theoretically fully understood at this time, thus the computational efforts described here (and in [1, 2]) to try to resolve matters further.

Off-shell parameter	Asymptotic Real Component (RC)	Asymptotic RC FWHM	Asympt. RC 1/Variance
δx_9	0.9823	0.0047	***246,819***
δx_{10}	0.9361	0.0044	***281,623***
δx_{11}	0.9585	0.0030	***605,803***
δx_{12}	0.9856	0.0021	***1,236,332***
δx_{13}	0.9953	0.0017	***1,886,583***
δx_{14}	0.9343	0.0029	***648,302***
δx_{15}	0.9745	0.0023	***1,030,666***
δx_{17}	0.9644	0.0039	***358,463***
δx_{18}	0.9745	0.0050	***218,089***
δx_{19}	0.9799	0.0060	***151,450***
δx_{20}	0.9792	0.0053	***194,098***
δx_{21}	0.9639	0.0048	***236,641***
δx_{22}	0.9797	0.0028	***695,436***
δx_{23}	0.9593	0.0037	***398,263***
δx_{24}	0.9826	0.0066	***125,165***
δx_{25}	0.9979	0.0012	***3,786,267***
δx_{26}	0.9615	0.0059	***156,628***
δx_{27}	0.9892	0.0041	***324,344***
δx_{28}	0.9497	0.0051	***209,620***
δx_{29}	0.9326	0.0052	***201,635***
δx_{30}	0.9710	0.0022	***1,126,493***
δx_{31}	0.9706	0.0020	***1,363,056***

Table 1. The 22 letters of reality. The 'letters' are emergent real parameters (i.e., just numbers, the 'best' set shown in bold in right column) from an iterative process involving repeated chiral bi-sedenion multiplication. If noise injection at non-propagating ("off-shell") parameter x_9 is introduced then have non-zero components $\{\Delta x_0, \delta x_1, \delta x_2,\ldots\delta x_7, \delta x_8, \boldsymbol{\delta x_9}, \delta x_{16}\}$. The table lists the off-shell parameter, its asymptotic rc value, the full-width at half maximum (FWHM) of the peak (FWHM=2.335σ), and the inverse of the variance (taken as the best set of 'letters' available at this time).

5 Discussion

From the bi-sedenions we find maximal information propagation entails:

(1) 10 dimensions (or weighting factors) on propagation path (or on letter-sequence comprising 'word'). The path is assigned a phase 'score'; the word is assigned a gematria score. The 10 dimensions comprise a chiral subspace of the 32-dim bi-sedenion

(2) 22 parameters/letters are emergent.

(3) Three generations of matter are evident from the structure of the chiral bisedenion: ($(a,\alpha),(\beta,\gamma)$), where γ = "0" = (0,0,0,0,0,0,0,0), and α and β are real octonions with $\alpha = (\alpha,0,0,0,0,0,0,0)$ and $\beta = (\beta,0,0,0,0,0,0,0)$. In the imaginary

octonion components of γ, β, and α, we have three clear generations present of non-propagating, emergent parameters.
(4) Information propagation is carried via 137 paths with different algebraic ‘braid’ or three-octonion-product algebraic terms, plus part of an added ‘path’ associated with an emergent pure imaginary octonion. 1/137 becomes the approximate limit on allowed perturbation amplitude, as shown in the Results. Likewise, 137 also presents a special value in the ancient Babylonian/Jewish gematria word-scoring encoding & systems.
(5) The added complex term indicated in (4) represents the addition of an added dimension or weighting factor, to a limited degree, thus the 10 dimensions touted in (1) sometimes have an 11th dimension. This jibes with the mysterious results seen in physics that euclideanization (continuation of time parameter into imaginary) provides meaningful information about the system (typically its thermodynamic and statistical mechanics properties). Similarly this jibes with the addition of an 11th node in ancient gematria word scoring systems (the Sefirot diagram has 10 or 11 nodes, or sefiroth).

5.1 Evolution of man-made written systems arrive at 22 letters

It is worthy of note that the existing gematria word-scoring system, and the 22-letter alphabet it works on, would have had hundreds of years to seek optimization at the hands of scribes painstakingly transcribing messages in difficult media (clay tablet, papyrus, etc.). Gematria was an ancient system for encoding messages used by the Babylonians and subsequently adopted by the Hebrew people while under Babylonian control, and it grew in both cases to have religious/numerological significance (part of the standard religion for Babylonians for 800 hundred years, adopted by some Jewish sects up to what is modern day Kabbalah). The gematria word-scoring scheme can be seen as a recursively stable bi-sedenion optimization or propagation (via its choice of 10 dim and 22 letters, in a 32-dim bisedenion). Just as the ancient Greeks were fascinated with the recursive properties of the golden rectangle, incorporating its ‘magic’ into the choice of the temple foundations and column spacing, etc., the same can be said for the ancient Babylonians/Hebrews as regards the transcription of their religious texts. It appears these texts are ‘gematriafied’, thereby incorporating the ‘magic’ or maximal bisedenion info encoding/transmission into their word foundations.

5.2 Evolution of biological written systems arrive at 22 letters

Biological information involves two written systems, one with nucleic acid polymer bases (4 DNA or RNA letters), and one amino acid (AA) polymer based (22 AA letters). The nucleic acid polymer system is thought to be more ancient,

existing before protein (protein is a ‘long’ AA polymer, while a peptide is a ‘short’ AA polymer). This is known as the RNA World Hypothesis [7]. The original nucleic acid language was optimized for information storage more than transmission/functionality, and is still retained for that purpose by biological systems.
Evidently the nucleic acid words written in 4 letters, over vast stretches of evolutionary time, began to have groupings for optimal information transmission (where optimality is selected by evolution). In time, these groupings actually provided a template and mechanism for creating ‘words’ in a new, amino acid based, alphabet system. These new types of biological words were tasked with exploring the entire space of functional possibilities (of biomolecules), thus lent themselves to the typical 22-letter, 10/11 weight-factor (dimension), optimization result. In ancient gematria the 22 letters are separated into three groups (with different ‘weight’ factors accordingly): the 3 mother letters (aleph, mem, shin); the 7 double letters (beth, gimel, daleth,kaph,pe,resh,tau); and the 12 simple letters (he, vau, zain, cheth, teth, yod, lamed, nun, samekh, ayin, tzaddi, qoph). If we want to look for a similar splitting into subgroups on properties of the amino acids we don’t have to look far, as the 22 amino acid ‘letters’ are similarly split into groups of 3, 7, 12: there are 3 punctuation types of letter (2 stop types, one start); 7 hydrophobic AAs (alanine, isoleucine, leucine, phenylalanine, proline, tryptophan, valine), excluding methionine, which codes for ‘start’; and 12 hydrophilic AAs (arginine, asparagine, aspartate, cysteine, glutamate, glutamine, glycine, histidine, lysine, serine, threonine, tyrosine). Other parallels exist as well, and not surprisingly so, if they are both an optimized information transmission/functionality processes that must relate to bi-sedenion propagation (or weighting) in a 10 element scheme, with emergent ‘letters’ in that scheme numbering 22.

Since this 22 letter AA alphabet is highly suggestive of a successful bi-sedenion encoding optimization, this begs the question of what might biochemically correspond to the 10 (or 11) elements in the gematria-like optimized encoding scheme? This would indicate a ‘scoring’ on protein words as with text words. Such scorings on hydrophobicity, etc., have already been employed by biologists, but it might be possible that an optimal ‘gematria’ scoring system is already built-in, waiting to be discovered. So what might make up the elements in weighting the different amino acids? We have the standard hydrophilic vs hydrophobic; polar vs nonpolar; small vs large; monosteric vs allosteric (as a split that sometimes occurs, especially with complexities of hydrogen bonding); and AA’s mostly reserved for punctuation (1 start or 2 stops). Counting the polarization pairs of ‘this vs that’ as two elements impacting weighting, then the number of elements impacting the weighting assigned to a ‘letter’ (AA in this instance) is 10 or 11 according to whether allostericity is present. So an exact match with what would be expected of an optimized bi-sedenion formulation. It is interesting to note that the richness of the 10/11 parameter polymer scoring/functionalization-capabilities in aqueous solution may not be possible in non-aqueous solutions. Life may require water-based biochemical processes to effectively code for functionality in the geologic time-scales in which it can exist (before catastrophic environmental change).

5.3 Propagation of physical information arrive at ‘words’ consisting of 22 letters

The breakdown on the emergent 22 parameters in the case of the 19 parameters of the standard model plus the minimal neutrino extension [8, 9] (have three new mass parameters for three sterile neutrinos) can similarly be done. The minimal extended standard model has 3 generations of four mass parameters, so 12 masses to correspond with the 12. Likewise, there are 7 ‘angle’ or ‘coupling’ parameters, and 3 other parameters having to do with Higgs or phase.

5.4 Note on optimal information transmission

The bi-sedenion optimization results for maximal information transmission [1], may also serve another purpose in identifying a new data compression/encoding scheme. If a 22 symbol alphabet is a fundamental, together with 10 parameter weighting scheme, it may be that most of the benefits of that optimal encoding can be obtained by simply remapping to a 22-symbol encoding scheme followed by one of the usual non-lossy compression methods.

5.5 Oddities of the non-integer part of 1/alpha

In the Results a derivation is given of 137 ‘complete’ braid transmission channels for propagating information, and of a partial 138 braid channel (that is pure imaginary). If we take the experimental result from QED, we know the magnitude of the contribution from the 138^{th} channel to be 0.0359907. The appearance of a complex value in association with ‘time’ appears in thermodynamics and statistical mechanics, and is an underlying construct in thermal quantum field theory. So the appearance of a small complex contribution is no minor thing as it may provide the explanation for why the variety of euclideanization methods work, and may provide a better understanding of time (especially in quantum systems).

6 Conclusion

Maximal information propagation appears to entail communication with 22 'letters' operating with a weighting scheme dependent on a 10 (sometimes 11) dimensional propagation or node-linkage weighting scheme. A 'quirk' of all of these maximal information propagation systems is that an important coupling term, alpha, or word score, is nearly exactly the integer 137. In the theoretical analysis of the chiral propagation we see not only 'why 137', we also see why there's a little extra (since alpha=137.035999070), and arrive at a theoretical derivation for alpha It is found that the fractional part of 137 relates to propagation that extends outside the 10 dim bisedenion subspace to a 11^{th} dimensional subspace (within the 32dim bi-sedenions). In other areas of communication it is, therefore, not surprising that the highly optimized languages/systems described involve 22 letters.

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