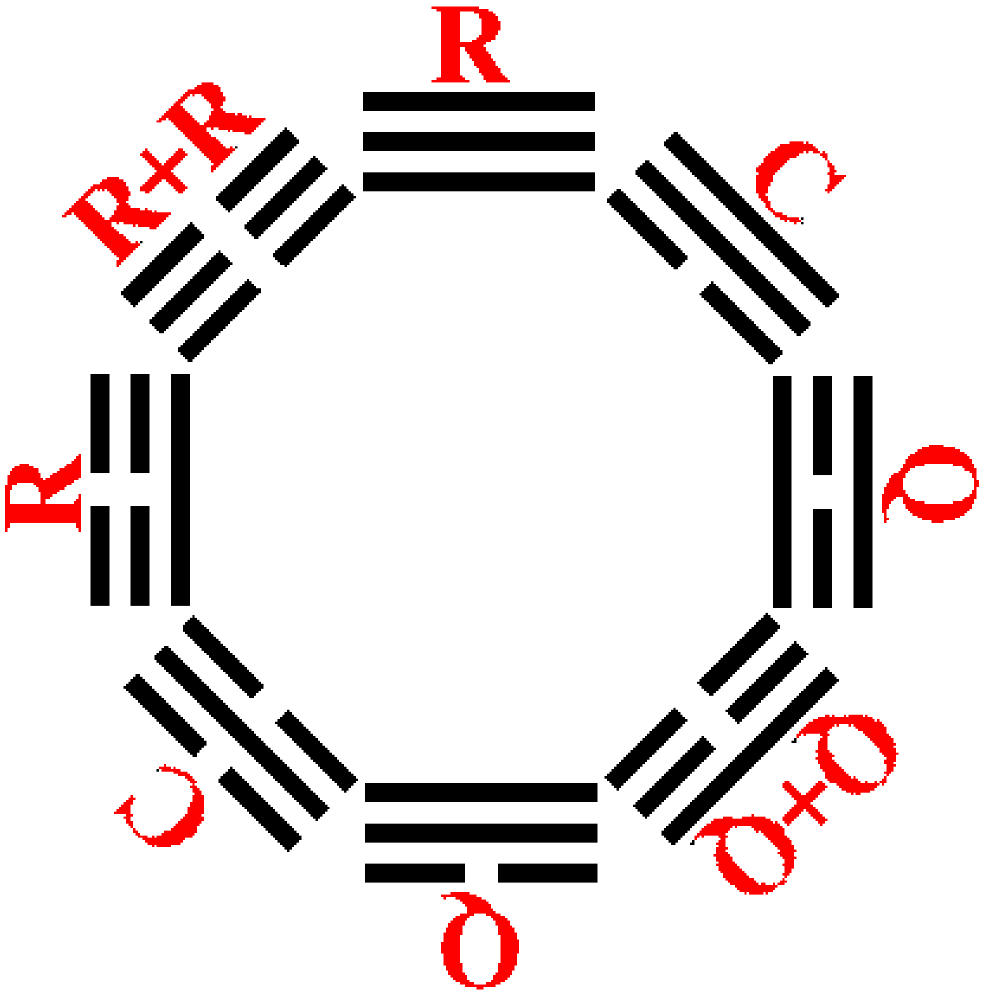
Clifford Algebras in the Growth of Matter in Vedic Physics

By John Frederic Sweeney



Abstract

In our combinatorial universe, matter grows in a particular way, according to specific steps. The (n + 1) character of this growth lends itself easily to the Clifford Algebra and Clifford Spinor spaces which develop in the fashion of Mount Meru or Pascal's Triangle. This style of development leads to Fibonacci Numbers and the Golden Section which implies that these concepts are deeply entwined in the formation of matter. This paper gives a step by step explanation of the process and a lengthy exposition on Clifford Algebras by physicist Frank "Tony" Smith from his monumental website.

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Introduction

Vedic Physics provides a simple explanation of nuclear physics, far less convoluted and complicated than western physics. Vedic Physics contains no competing theories, half – baked or nine – tenths cooked. Vedic Physics simply consists of a comparatively simple explanation for the atom. While far simpler, Vedic Physics is far more advanced, a remnant of a civilization that was far superior to our own, and which encompassed the people of the Vedas, ancient Egypt and perhaps a few other ancient civilizations such as the Maya or other ancient peoples from Mexico and South America.

Though more advanced than our own, those civilizations could not escape the periodic great floods and pole shifts inherent on our planet, and so much of the evidence of their existence has been flooded away, and we have few clues to their magnificence. Yet the Sanskrit language was specifically devised for just such an emergency, and the Vedas, starting with the Rig Veda, were composed to secretly contain the highest knowledge of those civilizations. A portion of that knowledge is given here, and then blended with contemporary mathematical physics so as to provide a stepping stone from below, to a higher level of understanding.

This paper first gives the Vedic explanation of the formation of the atom, and then follows this with a lengthy and explicit discussion of the Clifford Algebra from Wikipedia and from physicist Frank “Tony” Smith, to illustrate how Clifford Algebras can best be used to work with nuclear physics. Much of Smith’s work is informed by ancient mathematics, and so his work comes closest to approximating the superior science of 14,000 years ago.

Ours is a combinatorial universe, which develops one pulse or beat after another, and consists of three types of matter: dynamic Rajic (9 x 9), stable Satvic (8 x 8) or Thaamic (functional and non – functional Dark Matter). For this reason combinatorial methods are best suited to study and understanding of phenomena in our universe.

Clifford Algebra connects easily to Bott Periodicity, as well as to Pisano (Fibonacci) Periodicity and to the Five Elements of Hindu and Chinese metaphysics. Clifford Algebra connects as well to the series of Exceptional Lie Algebras, which form isomorphic relations with another key concept of Vedic Nuclear Physics, the Hyper – Circle. Thus the author hopes the present paper provides sufficient foundation for further study of Vedic Nuclear Physics for western learners.

Vedic Explanation of (n + 1) Structure

The following explanation originates from a textbook called Vedic Particle Physics by Khem Chand Sharma:

Euclidean view of the geometries of the regular bodies: When the structure of the regular body of n – dimensional space is completely formed by RTA flow inside that space, then the domain of that regular body will be An. RTA flow remains continuous in every dimensional space.

When the structure of the regular body of an n – dimensional space having An as its domain gets completed by that flow, then the excess RTA flow pushes this regular body as a whole into the next (n + 1) dimensional space, and gets its spot vacated for the new structure of the same type. This process goes on continuously.

Now this regular body having its domain as An becomes the component of the frame part of the next regular body of the (n + 1) dimensional space. So the n – dimensional regular body becomes the component of the frame parts of the (n + 1) dimensional body. The domain of the previous space becomes the frame of the next space.

The Rig Veda mantra (RG – 1 – 164 – 50) describes this transition process. The construction of the regular body is considered a Yajna of the god concerned with that space in a particular Loka, operated by RTA flow of Devas from one Loka to another.

Wikipedia on Clifford Classification

In abstract algebra, in particular in the theory of nondegenerate quadratic forms on vector spaces, the structures of finite-dimensional real and complex Clifford algebras have been completely classified. In each case, the Clifford algebra is algebra isomorphic to a full matrix ring over **R**, **C**, or **H** (the quaternions), or to a direct sum of two such algebras, though not in a canonical way. Below it is shown that distinct Clifford algebras may be algebra isomorphic, as is the case of $C\ell_{2,0}(\mathbf{R})$ and $C\ell_{1,1}(\mathbf{R})$ which are both isomorphic to the ring of two-by-two matrices over the real numbers.

Notation and conventions

The Clifford product is the manifest ring product for the Clifford algebra, and all algebra homomorphisms in this article are with respect to this ring product. Other products defined within Clifford algebras, such as the exterior product, are not used here. This article uses the (+) sign convention for Clifford multiplication so that

$$v^2 = Q(v)$$

for all vectors $v \in V$, where Q is the quadratic form on the vector space V. We will denote the algebra of $n \times n$ matrices with entries in the division algebra K by $M_n(K)$ or $M(n, K)$. The direct sum of two such identical algebras will be denoted by $M_n^2(K) = M_n(K) \oplus M_n(K)$.

Bott periodicity

Clifford algebras exhibit a 2-fold periodicity over the complex numbers and an 8-fold periodicity over the real numbers, which is related to the same periodicities for homotopy groups of the stable unitary group and stable orthogonal group, and is called Bott periodicity.

The connection is explained by the geometric model of loop spaces approach to Bott periodicity: there 2-fold/8-fold periodic embeddings of the classical groups in each other (corresponding to isomorphism groups of Clifford algebras), and their successive quotients are symmetric spaces which are homotopy equivalent to the loop spaces of the unitary/orthogonal group.

Complex case

The complex case is particularly simple: every non - degenerate quadratic form on a complex vector space is equivalent to the standard diagonal form

$$Q(u) = u_1^2 + u_2^2 + \cdots + u_n^2$$

where $n = \dim V$, so there is essentially only one Clifford algebra in each dimension. We will denote the Clifford algebra on $\mathbf{C}^n$ with the standard quadratic form by $C\ell_n(\mathbf{C})$.

There are two separate cases to consider, according to whether n is even or odd. When n is even the algebra $C\ell_n(\mathbf{C})$ is central simple and so by the Artin-Wedderburn theorem is isomorphic to a matrix algebra over $\mathbf{C}$. When n is odd, the center includes not only the scalars but the pseudoscalars (degree n elements) as well. We can always find a normalized pseudoscalar ω such that $\omega^2 = 1$. Define the operators

$$P_{\pm} = \frac{1}{2}(1 \pm \omega).$$

These two operators form a complete set of orthogonal idempotents, and since they are central they give a decomposition of $C\ell_n(\mathbf{C})$ into a direct sum of two algebras where $C\ell_n^{\pm}(\mathbf{C}) = P_{\pm}C\ell_n(\mathbf{C})$.

The algebras $C\ell_n^{\pm}(\mathbf{C})$ are just the positive and negative eigenspaces of ω and the $P_{\pm}$ are just the projection operators. Since ω is odd these algebras are mixed by α (the linear map on V defined by $v \mapsto -v$):

$$\alpha(C\ell_n^{\pm}(\mathbf{C})) = C\ell_n^{\mp}(\mathbf{C}).$$

and therefore isomorphic (since α is an automorphism). These two isomorphic algebras are each central simple and so, again, isomorphic to a matrix algebra over $\mathbf{C}$. The sizes of the matrices can be determined from the fact that the dimension of $C\ell_n(\mathbf{C})$ is 2^n. What we have then is the following table:

n	$C\ell_n(\mathbf{C})$
$2m$	$M(2^m, \mathbf{C})$
$2m+1$	$M(2^m, \mathbf{C}) \oplus M(2^m, \mathbf{C})$

The even subalgebra of $C\ell_n(\mathbf{C})$ is (non-canonically) isomorphic to $C\ell_{n-1}(\mathbf{C})$. When n is even, the even subalgebra can be identified with the block diagonal matrices (when partitioned into 2×2 block matrix). When n is odd, the even subalgebra are those elements of $M(2^m, \mathbf{C}) \oplus M(2^m, \mathbf{C})$ for which the two factors are identical. Picking either piece then gives an isomorphism with $C\ell_{n-1}(\mathbf{C}) \cong M(2^m, \mathbf{C})$.

Real case

The real case is significantly more complicated, exhibiting a periodicity of 8 rather than 2, and there is a 2-parameter family of Clifford algebras.

Classification of quadratic form

Firstly, there are non-isomorphic quadratic forms of a given degree, classified by signature.

Every non - degenerate quadratic form on a real vector space is equivalent to the standard diagonal form:

$$Q(u) = u_1^2 + \cdots + u_p^2 - u_{p+1}^2 - \cdots - u_{p+q}^2$$

where $n = p + q$ is the dimension of the vector space. The pair of integers (p, q) is called the signature of the quadratic form. The real vector space with this quadratic form is often denoted $\mathbf{R}^{p,q}$. The Clifford algebra on $\mathbf{R}^{p,q}$ is denoted $C\ell_{p,q}(\mathbf{R})$.

A standard orthonormal basis $\{e_i\}$ for $\mathbf{R}^{p,q}$ consists of $n = p + q$ mutually orthogonal vectors, p of which have norm +1 and q of which have norm −1.

Unit pseudoscalar

See also: Pseudoscalar

The unit pseudoscalar in $C\ell_{p,q}(\mathbf{R})$ is defined as

$$\omega = e_1 e_2 \cdots e_n.$$

This is both a Coxeter element of sorts (product of reflections) and a longest element of a Coxeter group in the Bruhat order; this is an analogy. It corresponds to and generalizes a volume form (in the exterior algebra; for the trivial quadratic form, the unit pseudoscalar is a volume form), and lifts reflection through the origin (meaning that the image of the unit pseudoscalar is reflection through the origin, in the orthogonal group).

To compute the square $\omega^2 = (e_1 e_2 \cdots e_n)(e_1 e_2 \cdots e_n)$, one can either reverse the order of the second group, yielding $\operatorname{sgn}(\sigma) e_1 e_2 \cdots e_n e_n \cdots e_2 e_1$, or apply a perfect shuffle, yielding $\operatorname{sgn}(\sigma)(e_1 e_1 e_2 e_2 \cdots e_n e_n)$. These both have sign $(-1)^{\lfloor n/2 \rfloor} = (-1)^{n(n-1)/2}$, which is 4-periodic (proof), and combined with $e_i e_i = \pm 1$, this shows that the square of ω is given by

$$\omega^2 = (-1)^{n(n-1)/2}(-1)^q = (-1)^{(p-q)(p-q-1)/2} = \begin{cases} +1 & p - q \equiv 0, 1 \mod 4 \\ -1 & p - q \equiv 2, 3 \mod 4. \end{cases}$$

Note that, unlike the complex case, it is not always possible to find a pseudoscalar which squares to +1.

Center

If n (equivalently, $p - q$) is even the algebra $C\ell_{p,q}(\mathbf{R})$ is central simple and so isomorphic to a matrix algebra over $\mathbf{R}$ or $\mathbf{H}$ by the Artin–Wedderburn theorem.

If n (equivalently, $p - q$) is odd then the algebra is no longer central simple but rather has a center which includes the pseudoscalars as well as the scalars. If n is odd and $\omega^2 = +1$ (equivalently, if $p - q \equiv 1 \pmod 4$) then, just as in the complex case, the algebra $C\ell_{p,q}(\mathbf{R})$ decomposes into a direct sum of isomorphic algebras

$$C\ell_{p,q}(\mathbf{R}) = C\ell^{+}_{p,q}(\mathbf{R}) \oplus C\ell^{-}_{p,q}(\mathbf{R})$$

each of which is central simple and so isomorphic to matrix algebra over $\mathbf{R}$ or $\mathbf{H}$.

If n is odd and $\omega^2 = -1$ (equivalently, if $p - q \equiv -1 \pmod 4$) then the center of $C\ell_{p,q}(\mathbf{R})$ is isomorphic to $\mathbf{C}$ and can be considered as a *complex* algebra. As a complex algebra, it is central simple and so isomorphic to a matrix algebra over $\mathbf{C}$.

Classification

All told there are three properties which determine the class of the algebra $C\ell_{p,q}(\mathbf{R})$:

- signature mod 2: n is even/odd: central simple or not
- signature mod 4: $\omega^2 = \pm 1$: if not central simple, center is $\mathbf{R} \oplus \mathbf{R}$ or $\mathbf{C}$
- signature mod 8: the Brauer class of the algebra (n even) or even subalgebra (n odd) is $\mathbf{R}$ or $\mathbf{H}$

Each of these properties depends only on the signature $p - q$ modulo 8. The complete classification table is given below. The size of the matrices is determined by the requirement that $C\ell_{p,q}(\mathbf{R})$ have dimension 2^{p+q}.

$p-q$ mod 8	ω^2	$C\ell_{p,q}(\mathbf{R})$ ($n = p+q$)	$p-q$ mod 8	ω^2	$C\ell_{p,q}(\mathbf{R})$ ($n = p+q$)
0	+	$M(2^{n/2},\mathbf{R})$	1	+	$M(2^{(n-1)/2},\mathbf{R}) \oplus M(2^{(n-1)/2},\mathbf{R})$
2	−	$M(2^{n/2},\mathbf{R})$	3	−	$M(2^{(n-1)/2},\mathbf{C})$
4	+	$M(2^{(n-2)/2},\mathbf{H})$	5	+	$M(2^{(n-3)/2},\mathbf{H}) \oplus M(2^{(n-3)/2},\mathbf{H})$
6	−	$M(2^{(n-2)/2},\mathbf{H})$	7	−	$M(2^{(n-1)/2},\mathbf{C})$

It may be seen that of all matrix ring types mentioned, there is only one type shared between both complex and real algebras: the type $\mathbf{C}(2^m)$. For example, $C\ell_2(\mathbf{C})$ and $C\ell_{3,0}(\mathbf{R})$ are both determined to be $\mathbf{C}(2)$. It is important to note that there is a difference in the classifying isomorphisms used. Since the $C\ell_2(\mathbf{C})$ is algebra isomorphic via a $\mathbf{C}$-linear map (which is necessarily $\mathbf{R}$-linear), and $C\ell_{3,0}(\mathbf{R})$ is algebra isomorphic via an $\mathbf{R}$-linear map, $C\ell_2(\mathbf{C})$ and $C\ell_{3,0}(\mathbf{R})$ are $\mathbf{R}$-algebra isomorphic.

A table of this classification for $p + q \leqslant 8$ follows. Here $p + q$ runs vertically and $p - q$ runs horizontally (e.g. the algebra $C\ell_{1,3}(\mathbf{R}) \cong M_2(\mathbf{H})$ is found in row 4, column −2).

	8	7	6	5	4	3	2	1	0	−1	−2	−3	−4	−5	−6	−7	−8
0									$\mathbf{R}$								
1								$\mathbf{R}^2$		$\mathbf{C}$							
2							$M_2(\mathbf{R})$		$M_2(\mathbf{R})$		$\mathbf{H}$						
3						$M_2(\mathbf{C})$		$M_2^2(\mathbf{R})$		$M_2(\mathbf{C})$		$\mathbf{H}^2$					
4					$M_2(\mathbf{H})$		$M_4(\mathbf{R})$		$M_4(\mathbf{R})$		$M_2(\mathbf{H})$		$M_2(\mathbf{H})$				
5				$M_2^2(\mathbf{H})$		$M_4(\mathbf{C})$		$M_4^2(\mathbf{R})$		$M_4(\mathbf{C})$		$M_2^2(\mathbf{H})$		$M_4(\mathbf{C})$			
6			$M_4(\mathbf{H})$		$M_4(\mathbf{H})$		$M_8(\mathbf{R})$		$M_8(\mathbf{R})$		$M_4(\mathbf{H})$		$M_4(\mathbf{H})$		$M_8(\mathbf{R})$		
7		$M_8(\mathbf{C})$		$M_4^2(\mathbf{H})$		$M_8(\mathbf{C})$		$M_8^2(\mathbf{R})$		$M_8(\mathbf{C})$		$M_4^2(\mathbf{H})$		$M_8(\mathbf{C})$		$M_8^2(\mathbf{R})$	
8	$M_{16}(\mathbf{R})$		$M_8(\mathbf{H})$		$M_8(\mathbf{H})$		$M_{16}(\mathbf{R})$		$M_{16}(\mathbf{R})$		$M_8(\mathbf{H})$		$M_8(\mathbf{H})$		$M_{16}(\mathbf{R})$		$M_{16}(\mathbf{R})$
ω^2	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−	+	+

Symmetries

There is a tangled web of symmetries and relationships in the above table.

$$C\ell_{p+1,q+1}(\mathbf{R}) = \mathrm{M}_2(C\ell_{p,q}(\mathbf{R}))$$

$$C\ell_{p+4,q}(\mathbf{R}) = C\ell_{p,q+4}(\mathbf{R})$$

Going over 4 spots in any row yields an identical algebra.

From these Bott periodicity follows:

[illegible]

If the signature satisfies $p - q \equiv 1 \pmod 4$ then

$$C\ell_{p+k,q}(\mathbf{R}) = C\ell_{p,q+k}(\mathbf{R}).$$

(The table is symmetric about columns with signature 1, 5, −3, −7, and so forth.) Thus if the signature satisfies $p - q \equiv 1 \pmod 4$,

$$C\ell_{p+k,q}(\mathrm{R}) = C\ell_{p,q+k}(\mathrm{R}) = C\ell_{p-k+k,q+k}(\mathrm{R}) = \mathrm{M}_{2^k}(C\ell_{p-k,q}(\mathrm{R})) = \mathrm{M}_{2^k}(C\ell_{p,q-k}(\mathrm{R})).$$

Frank “Tony” Smith on Clifford Algebras

Why Cliffords

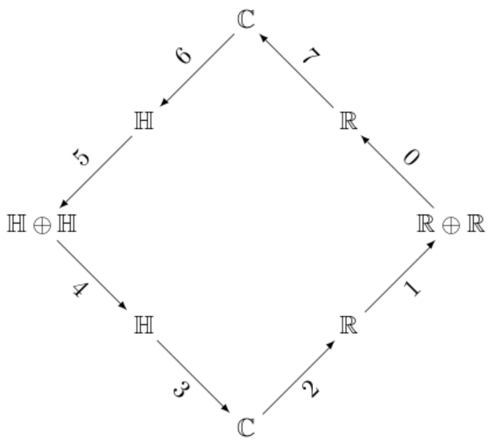
Well, here is a little table up to n = 8:

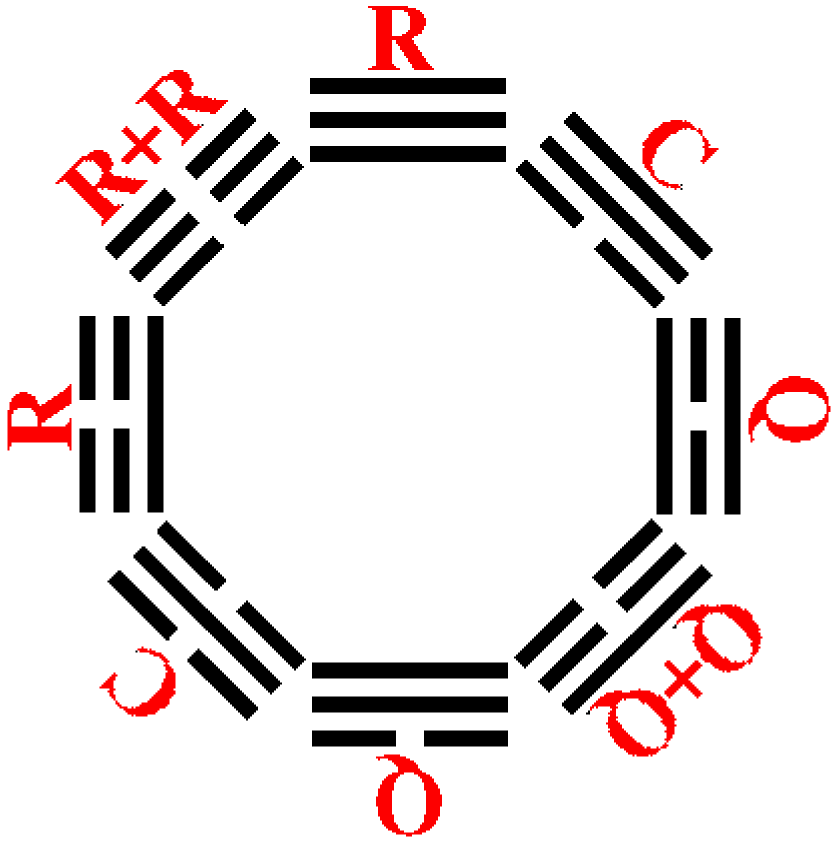
C_0	R
C_1	C
C_2	H
C_3	H + H
C_4	H(2)
C_5	C(4)
C_6	R(8)
C_7	R(8) + R(8)
C_8	R(16)
C_9	R(32)

$$
\begin{aligned}
\mathrm{Cl}_{10} &= \mathbb{R} \oplus \mathbb{R} \\
\mathrm{Cl}_{20} &= M_2(\mathbb{R}) \\
\mathrm{Cl}_{30} &= M_2(\mathbb{C}) \\
\mathrm{Cl}_{40} &= M_2(\mathbb{H}) \\
\mathrm{Cl}_{50} &= M_2(\mathbb{H}) \oplus M_2(\mathbb{H}) \\
\mathrm{Cl}_{60} &= M_4(\mathbb{H}) \\
\mathrm{Cl}_{70} &= M_8(\mathbb{C}) \\
\mathrm{Cl}_{80} &= M_{16}(\mathbb{R})
\end{aligned}
\tag{1.4}
$$

Two algebras Cl_{10} and Cl_{50} are direct sums of simple algebras, and the others are simple. We could also define $\mathrm{Cl}_{00} = \mathbb{R}$ (the base field), so that Corollary 1.8 holds even when $p = q = 0$.

Those eight algebras Cl_{p0} can be arranged on a "spinorial clock", which is taken from Budinich and Trautman's book [BT].





What do these entries mean?

Well, R(n) means the n x n matrices with real entries.
Similarly, C(n) means the n x n complex matrices,
and H(n) means the n x n quaternionic matrices.

All these become algebras with the usual matrix addition
and matrix multiplication.

Finally, if A is an algebra,
A + A means the algebra consisting of pairs of guys in A,
with the obvious rules for addition and multiplication:

Chris Tickle, in August 2001, asked me about Clifford algebras:
"... What would be the first thing you would tell me,
what would be the first example you would show me, and
what would be the first application you would show me? ...".

Here is substantially what I said in reply:

The first thing that I would tell you would be that Clifford algebras
(working over the real numbers and using Euclidean signature)

have the structure of the binomial triangle,

so that the Clifford algebra Cl(n) has structure like:

```
n                                  Total
                                 Dimension

0                 1                2^0 =   1= 1x1
1               1   1               2^1 =   2= 1+1
2             1   2   1              2^2 =   4= 2x2
3           1   3   3   1             2^3 =   8= 4+4
4         1   4   6   4   1            2^4 =  16= 4x4
5       1   5  10  10   5   1           2^5 =  32= 16+16
6     1   6  15  20  15   6   1          2^6 =  64= 8x8
7   1   7  21  35  35  21   7   1         2^7 = 128= 64+64
8  1   8  28  56  70  56  28   8   1    2^8 = 256= 16x16
9 1   9  36  84  126 126 84  36   9  1  2^9 = 512= 256+256
```

... etc ...

The first example that I would show you would be the simplest:

Cl(0) is 1-dimensional and looks like the real numbers.

To me this is important because it means that very big Cl(n) \algebras arise naturally from the single element 0. It lets me, build a math model for the whole universe from 0,

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The first "application" would be that
Cl(2) is 4-dimensional (it is the quaternions), but its graded structure is

1 2 1

The first 1 (called grade 0) is the scalars (here I am working with real numbers as scalars).

The 2 (called grade 1) is a 2-dimensional vector space (which I take to be the complex plane). This illustrates that the grade-1 elements of Clifford algebras form vector spaces, and can be called vectors.

The second 1 (called grade 2) is the Lie algebra of the rotation group of the plane, the 1-dimensional U(1) circle rotation group. This illustrates that the grade-2 elements of Clifford algebras form the Lie algebra of rotations in the space of vectors, and the grade-2 elements can be called bivectors.

(As a remark, note that I skipped Cl1), with structure 1+1, which is the complex numbers. In a real lecture I might mention that I skipped Cl(1) to get to Cl(2).)

==

Cl(3) has structure 1 3 3 1, with 3-dim vectors and 3-dim bivectors, representing the 3-dim Lie algebra of rotations in 3-dim space;

Cl(4) has structure 1 4 6 4 1, with 4-dim vectors and 6-dim bivectors, representing the 6-dim Lie algebra of rotations in 4-dim space (if you go to Minkowski signature, the 6-dim Lie algebra gives you 3-dim spatial rotations plus 3-dim Lorentz boosts); and

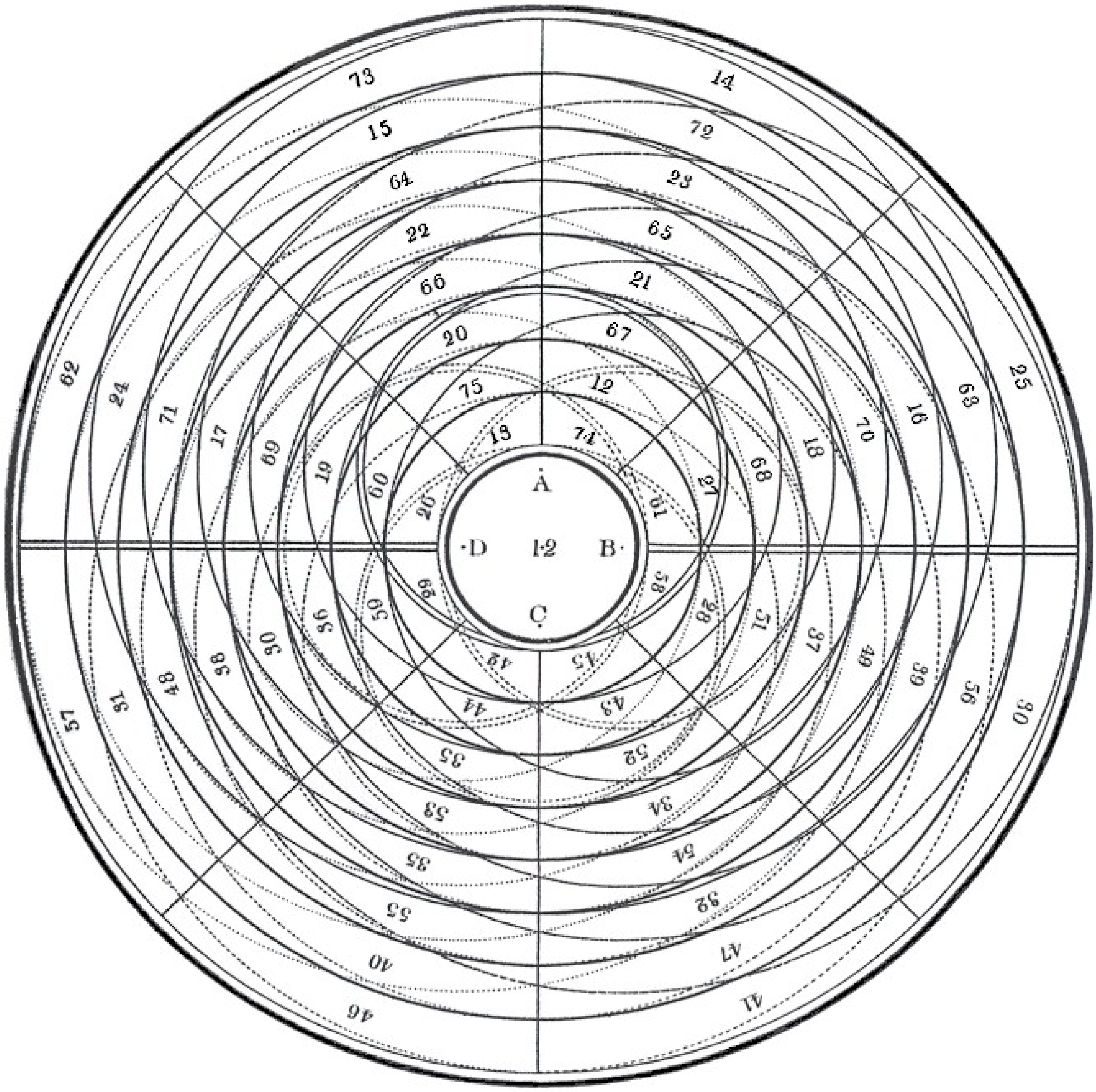
If you go up to large n (large with respect to 8), the structure of Cl(n) can be understood by using a factorization theorem, the Periodicity Theorem:

Cl(n) = Cl(8) x Cl(n-8)   (where x denotes tensor product).

Therefore, ALL Clifford algebras can be understood in terms of Cl(8) and the Cl(k) for k less than 8, so, in a sense, Cl(8) is the fundamental building block of ALL big Clifford algebras, because they can be embedded in a Cl(8n) = Cl(8) x ...(n times)... x Cl(8)

which is just a tensor product of a lot of Cl(8) algebras. That is why Cl(8) is the basic building block of my physics model.

Spinor Space



Vedic Nuclear Physics posits an atomic shell of 14 spaces or Lokas, 7 positive and 7 negative, almost like the Franklin Magic Circle above, which contains 8 levels.

For dimensions up to 8, here are the dimensions of spinors (with real structure) of the Clifford algebras:

n		Total Dimension	Spinor Dimension
0	1	2^0 = 1= 1x1	1
1	1 1	2^1 = 2= 1+1	1
2	1 2 1	2^2 = 4= 2x2	2 = 1+1
3	1 3 3 1	2^3 = 8= 4+4	2
4	1 4 6 4 1	2^4 = 16= 4x4	4 = 2+2
5	1 5 10 10 5 1	2^5 = 32=16+16	4
6	1 6 15 20 15 6 1	2^6 = 64= 8x8	8 = 4+4
7	1 7 21 35 35 21 7 1	2^7 = 128=64+64	8
8	1 8 28 56 70 56 28 8 1	2^8 = 256=16x16	16 = 8+8

To see why the restriction to real structure is important, consider, for example,

Cl(1,3) = M(2,Q) and Cl(3,1) = M(4,R)

Both are 16-dim Clifford algebras of 4-dimensional vector spaces,
although of different signatures -+++ and +---, but the full spinor space of real

Cl(3,1) is 4x1 = 4-dimensional,

while the full spinor space of quaternionic

Cl(1,3) is 2x4 = 8-dimensional.

As can be seen from the Clifford CheckerBoard Table, for any N there is always a signature (p,q) with p+q = N such that Cl(pq) has real structure.

Now, look at the Yang Hui triangle. The left-side border line is all 1's since there is only 1 dimension of scalars.

The next line is

1
2
3
4
5
6
7
8

the dimension of the vector space V(p,q) of the Clifford algebra Cl(p,q).

The next line is

```
        1        1
       3
      6
     10
    15
   21
  28
```

the dimension of the bivector subspace of the Clifford algebra.

The bivector subspace closes under the commutator
[a,b] = a.b - b.a operation, which defines the Lie algebra
of the Lie group Spin(p,q) of the Clifford algebra Cl(p,q).

Spin(p,q) is the simply connected (except for n=0,1,2)
2-1 covering group of the rotation group SO(p,q) of
the vector space V(p,q) underlying Cl(p,q).

EVERY REPRESENTATION OF Spin(p,q) CAN BE CONSTRUCTED FROM

the scalar graded subspace of Cl(p,q),
the vector graded subspace of Cl(p,q), and
the spinors (or two half-spinors, for even p+q)

BY USING THE OPERATIONS OF EXTERIOR /\ PRODUCT,
TENSOR PRODUCT, OR SUM or DIFFERENCE.

Exceptional Lie Algebra D5 Representation

An alternative, but equally valid, way to build a representation is to represent D5, not by nested hexagons, but by the following triangle:

1	Spin(2)=U(1)
2 3	Spin(3)=SU(2)=Sp(1)=S3
4 5 6	Spin(4)=Spin(3)xSpin(3)
7 8 9 10	Spin(5) = Sp(2)
11 12 13 14 15	Spin(6) = SU(4)
16 17 18 19 20 21	Spin(7)
Ks Kw Kc Kp Qs Qw Qc	Spin(8) = D4
Qp ks kw kc kp js jw jc	Spin(9)
jp 10s 10w 10c 0 10p 9s 9w 9c	Spin(10) = D5

Since E6 as used in the D4-D5-E6-E7 physics model represents the two half-spinor representations of Spin(8),

For Spin(n) up to n = 8,
here is their Clifford algebra structure
as shown by the Yang Hui (Pascal) triangle
and the dimensions of their spinor representations

n		Total Dimension	Spinor Dimension
0	1	2^0 = 1= 1x1	1
1	1 1	2^1 = 2= 1+1	1
2	1 2 1	2^2 = 4= 2x2	2 = 1+1
3	1 3 3 1	2^3 = 8= 4+4	2
4	1 4 6 4 1	2^4 = 16= 4x4	4 = 2+2
5	1 5 10 10 5 1	2^5 = 32=16+16	4
6	1 6 15 20 15 6 1	2^6 = 64= 8x8	8 = 4+4
7	1 7 21 35 35 21 7 1	2^7 = 128=64+64	8
8	1 8 28 56 70 56 28 8 1	2^8 = 256=16x16	16 = 8+8

Since each row of the Yang Hui (Pascal) triangle
corresponds to the graded structure of an exterior algebra
with a wedge product, call each row a wedge string.

In this pattern, the 28 and the 8 for n = 8 correspond
to the 28 gauge bosons of the D4 Lie algebra
and to the 8 spacetime (4 physical and 4 internal symmetry)
dimensions that are added when you go to the D5 Lie algebra.

The 8+8 = 16 fermions that are added when you go to E6,
corresponding to spinors, do not correspond to any single
grade of the n = 8 Clifford algebra with graded structure
1 8 28 56 70 56 28 8 1
but correspond to the entire Clifford algebra as a whole.

The total dimension of the Clifford algebra
is given by the Yang Hui (Pascal) triangle
pattern of binary expansion (1 + 1)^n,
which
corresponds to the number of vertices of
a hypercube of dimension n.

The spinors of the Clifford algebra of dimension n
are derived from the total matrix algebra of dimension 2^n
with pattern

n

0 1
1 2
2 4
3 8
4 16
5 32
6 64
7 128
8 256

This can be expanded to a pattern

n									
0	1								
1	2	1							
2	4	2	1						
3	8	4	2	1					
4	16	8	4	2	1				
5	32	16	8	4	2	1			
6	64	32	16	8	4	2	1		
7	128	64	32	16	8	4	2	1	
8	256	128	64	32	16	8	4	2	1

in the same form as the Yang Hui (Pascal) triangle.

Call each row a spinor string.

For a given row in the binary (1+1)^n Yang Hui (Pascal) triangle
the string product of a spinor string and a wedge string

(2^N, 2^(N-1), 2^(N-2), ... , 2^(N-J), ... , 4, 2, 1)
(1 , N , N(N-1)/2,...,N^k J^(N-k)/(k!(N-k)!)J),...,N(N-1)/2,N,1)

gives the rows of the ternary (1+2)^n power of 3 triangle

n										
0	1									3^0 = 1
1	2	1								3^1 = 3
2	4	4	1							3^2 = 9
3	8	12	6	1						3^3 = 27
4	16	32	24	8	1					3^4 = 81
5	32	80	80	40	10	1				3^5 = 243
6	64	192	240	160	60	12	1			3^6 = 729
7	128	448	672	560	280	84	14	1		3^7 = 2,187
8	256	1024	1792	1792	1120	448	112	16	1	3^8 = 6,561

Just as the binary (1+1)^n triangle corresponds to the I Ching,
the ternary (1+2)^n triangle corresponds to the Tai Xuan Jing.
The ternary triangle describes the sub-hypercube structure of a hypercube.

The ternary power of 3 triangle is not only
used in representations of the spinors in the D4-D5-E6-E7 model,
it was used by Plato in describing cosmogony and music.

(this is so because atoms produce music in a Pythagorean scale which corresponds to the Octonions, and the maxim, "As above, so below." In other words, atomic structure matches galactic structure.

The octonion algebra is an Alternative algebra,
but since it is non-associative the imaginary octonions
do not form a Lie algebra because J(a,b,c) = 6[a,b,c] =/= 0

Conclusion

This paper has introduced the formation of matter in Vedic Nuclear Physics, then linked this schema to Clifford Algebras and combinatorial math, as well as Mount Meru (Hui Triangle, Pascal's Triangle) which in turn relate to Fibonacci Numbers and to the Golden Section. Ultimately these relate to the Platonic Solids and combinations of such into icosahedrons and other advanced forms.

Clifford Algebras "dwell" in specific spaces we call Spinors, and Frank "Tony" Smith describes these and their specific relations to Clifford Algebras, here as well as on his website, and in numerous papers he has published on the Vixra and X Archiv sites.

Our combinatorial (n + 1) universe contains properties specific to that type of mathematics: the Golden Section, and its related geometry and the Mount Meru Pyramid. The author hypothesizes that the Golden Section mediates or provides a transition zone between dynamic Rajic (9 x 9) and stable Satvic (8 x 8), the two visible or detectable forms of matter in the universe. Given the different dynamics of each form, substances cannot simply jump from one state to the other, but perhaps must pass through a transition zone.

The Fibonacci Numbers inherently relate to the growth of matter in the universe, and the author hypothesizes that Fibonacci Numbers work with Fibonacci Periodicity and the Five Elements in the formation of matter. Moreover, Time is not a constant, as assumed in the west, but instead has a geography of its own, founded upon Base 60 Mathematics. This helps to account for the great variety in the universe, which contains a periodicity as well.

Researchers would do well to exploit these areas in favor of others. For this reason, this paper has marked out the nature of the atom, and provided the tools with which to explore. It remains to be seen what more can be discovered about this amazing science of our ancestors.

Contact

The author may be contacted at jaq2013 at outlook dot com

Some men see things as they are and say *why?* I dream things that never were and say *why not?*

Let's dedicate ourselves to what the Greeks wrote so many years ago:

to tame the savageness of man and make gentle the life of this world.

Robert Francis Kennedy