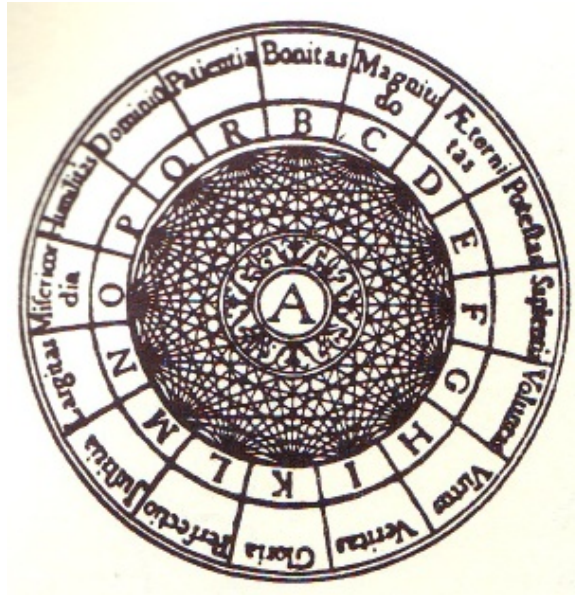


LLULL'S WHEELS:

Ramon Llull Connected Ancient Wisdom to 21st Century Science



Ramon Llull (ca 1232 to 1315) developed his A-wheel with 16 Elements by studying Arabic language and culture.

The Arabic Divination system Ilm al Raml is based on 16 Elements.

Llull showed 120 lines connecting distinct Pairs of the 16 Elements, so Llull was looking at Pairs of the 16 Elements.

There are in all $16 \times 16 = 256$ Pairs of 16 Elements.

The Arabic Divination system Ilm al Raml came from Africa, where the most Ancient Divination system IFA is based on 256 Elements seen as the result of casting 8 shells or coins to get 8 binary choices (face up or face down)



With a chain of 8 coins



there are

$$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$$

$$= 2^8 = 256 \text{ possible outcomes}$$

$$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$$

for 256 possibility Elements based on casting 8 shells or coins.

The 8+8 = 16 Elements in Llull's A-wheel were two sets of 8 Elements each,

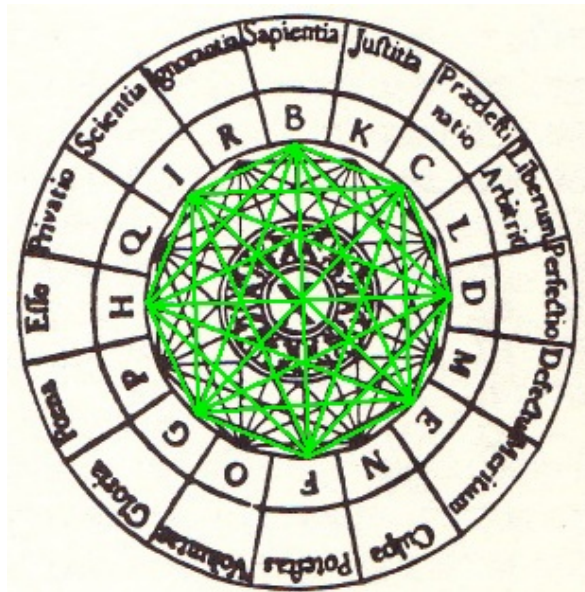
or two 8-Element sets of IFA Divination Coins,

which

Llull showed in his X-wheel with two sets of 8 Elements each.

Here one set of 8 Elements and their Pair-lines is shown in **Green**

and the othe set of 8 Elements and their Pair-lines is shown in **Black**.



To connect the Ancient Wisdom shown in Llull's wheels with 21st Century Science means that it must be interpreted in terms of the Language used by 21st Century Science, which is Mathematics.

Llull's X-wheel shows that Llull's 16 Element Structure (call it Llull(16)), factors into two independent 8 Element Structures (call each of them Llull(8)), so that by his X-wheel Llull is saying, in Mathematical Language:

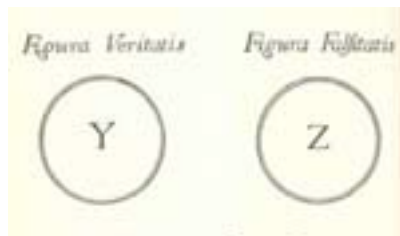
$$\text{Llull}(16) = \text{Llull}(8) \times \text{Llull}(8)$$

If you follow Llull's idea to its logical conclusion, go from $16 = 8 \text{ times } 2$ to $8 \text{ times } N$ for any (maybe very large) number N and get the factoring

$$\text{Llull}(8N) = \text{Llull}(8) \times \dots (N \text{ times}) \dots \times \text{Llull}(8)$$

There is a Mathematical Structure with that factoring property

that is based on the Binary Choice of Llull's wheels Y and Z



Real Clifford Algebras with 8-Fold Periodicity Factoring.

So, changing notation from Llull(16) to Cl(16) etc, because mathematicians mostly use the term Clifford Algebra, named for William Kingdon Clifford, who, over 100 years ago, wrote about such Algebras, the factoring is:

$$\text{Cl}(8N) = \text{Cl}(8) \dots (x) \dots (N \text{ times tensor product}) \dots (x) \dots \text{Cl}(8)$$

you can take the completion of the union of all the tensor products

to get what might be called a generalized Hyperfinite II₁ von Neumann Algebra factor

that represents a realistic Unified Physics Model including Gravity and the Standard Model,

So, consider each set of 8 Elements as an 8-dimensional Space.

The Simplest Geometric Objects in the 8-dimensional Octonion Space are:

- 0-dimensional points (there is only 1 general type, involving none of the Basis Element directions)
- 1-dimensional line Subspaces (8 general types, one in each of the Basis Element directions 1, i, j, k, E, I, J, K)
- 2-dimensional plane Subspaces (28 general types, each in a Pair of Basis Element directions)
- 3-dimensional Subspaces (56 general types, each in a Triple of Basis Element directions)
- 4-dimensional Subspaces (70 general types, each in a Quadruple of Basis Element directions)
- 5-dimensional Subspaces (56 general types, each in a Quintuple of Basis Element directions)
- 6-dimensional Subspaces (28 general types, each in a Sextuple of Basis Element directions)
- 7-dimensional Subspaces (8 general types, each in a Septuple of Basis Element directions)
- 8-dimensional Space itself (there is only 1, involving the Octuple of all the Basis Element directions)

There are $1+8+28+56+70+56+28+8+1 = 256$ of the Simplest Geometric Objects in 8-dimensional Space.

They fit together in the form of a Matrix Algebra that is in fact the Clifford Algebra over 8-dimensional Space,

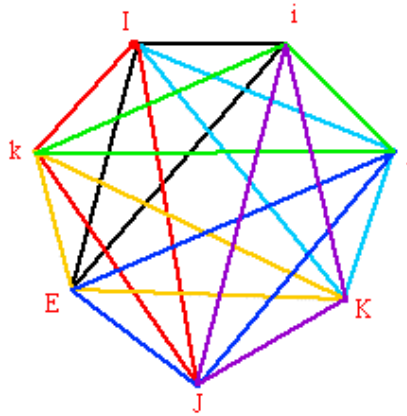
Cl(8).

Cl(8) is also called by some a Geometric Algebra because it is an Algebra that describes the Simplest Geometric Objects.

Each of the 8 Elements is a Basis Element of the 8-Dimensional Space, one of which is represented by the Real Number 1 and 7 of which are represented by the 7 Octonion Imaginary Numbers i, j, k, E, I, J, K .

(The Octonion Imaginary Numbers i, j, k, E, I, J, K are generalizations of the Complex Imaginary Number i .)

The points in the 8-dimensional Octonion Space can be multiplied with each other

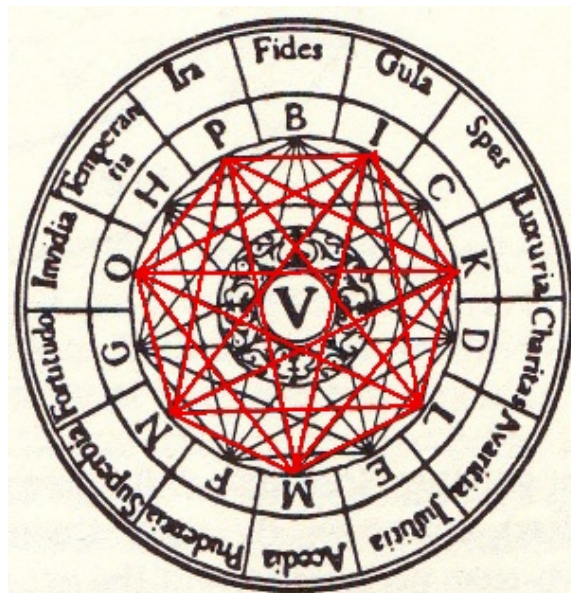


and the Octonion Multiplication Rules can be seen in terms of Pair-lines between the 7 Octonion Imaginary Elements

as shown by Llull in his V-wheel with two sets of 7 Elements and their Pair-lines.

Here one set of 7 Octonion Imaginary Elements and their Pair-lines is shown in Red

and the other set of 7 Octonion Imaginary Elements and their Pair-lines is shown in Black.



The Simplest Geometric Objects of the Clifford Algebra $Cl(8)$ are all Flat.

If you go beyond Flat to look at Curved things,

the Simplest Curved Geometric Objects in the 8-dimensional Octonion Space are:

- **Circles, which are 1-dimensional Spheres S_1**

- **2-dimensional Spheres S_2**

- **3-dimensional Spheres S_3**

- **4-dimensional Spheres S_4**

- **5-dimensional Spheres S_5**

- **6-dimensional Spheres S_6**

- **7-dimensional Spheres S_7**

The Maximal Sphere in 8-dimensional Octonion Space is the 7-sphere S_7 .

In each of the two sets of 7 Elements in Lull's V-wheel,

the 7 Elements represent the 7 dimensions of a 7-sphere S_7 .

If you use the Octonion Multiplication Rules, you can multiply points on the 7-sphere S_7 .

Some of the S_7 Multiplications produce points already in the 7-dimensional S_7 ,

but others produce points in a 21-dimensional Space whose 21 dimensions correspond to the 21 Pair-lines shown by Lull in his V-wheel, so

S_7 Multiplication produces a $7+21 = 28$ -dimensional Curved Geometric Object called a Lie Group,

denoted by $Spin(8)$ since it describes rotations in 8-dimensional Octonion Space.

The 28-dimensional Lie Group of S_7 Multiplication corresponds to the 28 Pair-lines of Lull's X-wheel,

that is, the 2-dimensional plane Subspaces (28 general types, each in a Pair of Basis Element directions),

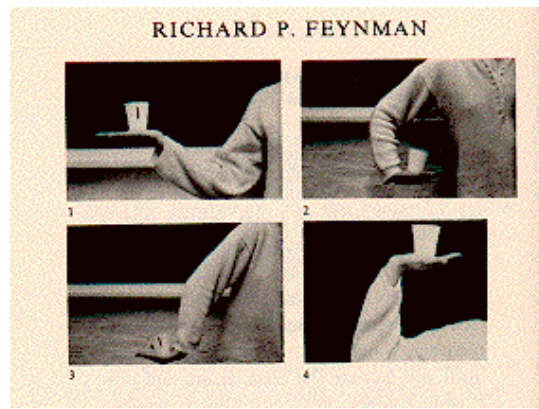
thus connecting the 2-dimensional plane Subspaces of the Clifford Algebra $Cl(8)$

with the Lie Group $Spin(8)$ that describes rotations in 8-dimensional Octonion Space.

$Spin(8)$ not only describes ordinary rotation in 8-dimensional Octonion Space,

it also describes the connection of the thing that is rotating with its surroundings.

A 3-dimensional example of Spin-Connection-With-Surroundings shows a cup held by a dancer in one hand. Rotating the cup by 360 degrees gets the arm (which is connected to the shoulder of the dancer) twisted, but turning the cup another 360 degrees gets the arm back straight:



- -
 -
 -
 -
 -
- picture 1 is the start,**
picture 2 is 180 degrees,
picture 3 is 360 degrees (note how the arm is twisted),
picture 4 is 540 degrees,
and picture 1 again is 720 degrees.

Since Spin-Connection-With-Surroundings action of Spin(8) takes 720 degrees (2 full rotations) to get back where it started, objects with Spin-Connection-With-Surroundings are called Spin 1/2 objects, or Spinors.

Since a Spinor must be rotated fully twice to get back where it started, a Spinor can be seen as a Square Root of a Rotation.

Mathematically in terms of the Clifford Algebra $Cl(8)$, there are $16 = \text{SquareRoot}(256)$ independent Spinors,

8 of which, because of the way their Spin-Connection-With-Surroundings works, are called +half-Spinors

and

the other 8 of which, because they look like mirror images of the first 8, are called -half-Spinors.

In the case of the 8-dimensional Octonionic Clifford Algebra $Cl(8)$:

the 8 basis Elements $1, i, j, k, E, J, K$ that define 1-dimensional line Subspaces, called $Cl(8)$ Vectors;

and

the 8 $Cl(8)$ +half-Spinors

and

the 8 $Cl(8)$ -half-Spinors

are functionally equivalent by what is called (since there are 3 types of things that are equivalent) Spin(8) Triality.

**At this point, using the A-wheel, X-wheel, and V-wheel
Llull has described the basic ingredients for a high-energy (around
Planck Energy) physics model with:**

Clifford Algebra $Cl(8) = 16 \times 16$ Real Matrix Algebra

8 $Cl(8)$ +half-Spinors representing the first-generation Fermion Particles

8 $Cl(8)$ -half-Spinors representing the first-generation Fermion Antiparticles

8 $Cl(8)$ Vectors representing the 8-dimensional spacetime that looks like $S^1 \times S^7$

28 Spin(8) Pair-line Elements representing 28 Gauge Bosons

The half-Spinor parts of the Llull Model already look realistic, by the correspondences:

- **1 = Neutrino**
- **i = Red Up Quark**
- **j = Green Up Quark**
- **k = Blue Up Quark**
- **E = Electron**
- **I = Red Down Quark**
- **J = Green Down Quark**
- **K = Blue Down Quark**

However, the Spacetime we see is 4-dimensional that looks like $S^1 \times S^3$

and

**our Standard Model for the $SU(3)$ Color Force, the $SU(2)$ Weak Force, and $U(1)$
Electromagnetism has $8+3+1 = 12$ Gauge Bosons**

and

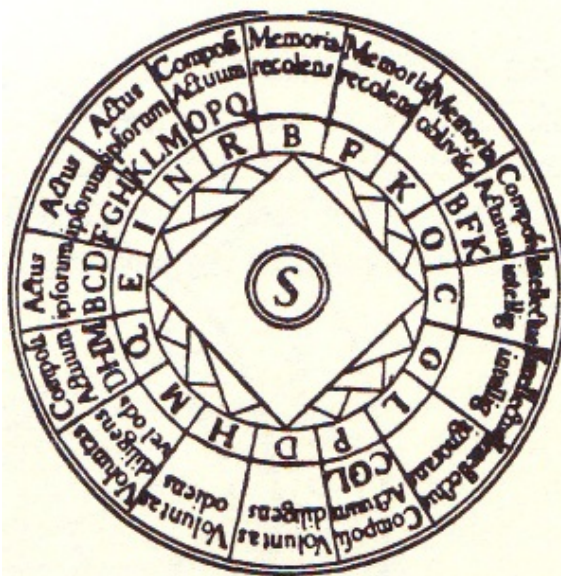
**Gravity can be seen, through a generalized MacDowell Mansouri mechanism, as due to 15
Gauge Bosons of the Conformal Group $SU(2,2) = Spin(2,4)$.**

**Llull's S-wheel and T-wheel show how to get our Spacetime and the
Standard Model and Gravity.**

Llull's S-wheel has a central S-square whose 4 corners represent { 1, i, j, k }, which are 4 of the 8 Cl(8) basis Elements.

{ 1, i, j, k } are basis Elements for a 4-dimensional Quaternionic Subspace that Freezes Out of high-energy 8-dimensional spacetime at lower (with respect to Planck Energy) energies.

That 4-dimensional Quaternionic Subspace is our 4-dimensional Physical Spacetime that looks like S1 x S3. The other 4 of 8 dimensions become a CP2 Internal Symmetry Space.



When that Quaternionic Structure is introduced, the 16x16 Real Matrix Algebra of Cl(8) is transformed into the 8x8 Quaternionic Matrix Algebra of Cl(2,6).

Since the 28-dimensional gauge group Spin(8) no longer has a unified 8-dimensional Spacetime on which to act, its 28 generators break down into 28 generators capable of acting on 4-dimensional Physical Spacetime S1xS3 and 4-dimensional CP2 Internal Symmetry Space and on the Fermion Particles and Antiparticles, which now come in 3 types, or generations:

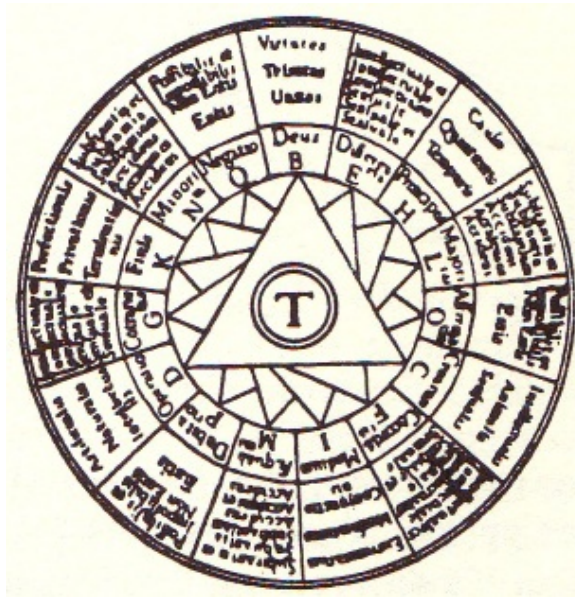
- 1 - living in S1xS3
- 2 - living in S1xS3 and CP2
- 3 - living in CP2

the U(1) propagator phase that is defined with respect to the fixed Quaternionic 4-dimensional spacetime subspace corresponding to the S-square of Llull's S-wheel

the 4 U(2) ElectroWeak Gauge Bosons (U(2) = SU(2) x U(1) for 3 Weak Bosons and 1 Electromagnetic Photon) are represented by the 4 corners of one of the three back squares of Llull's S-wheel

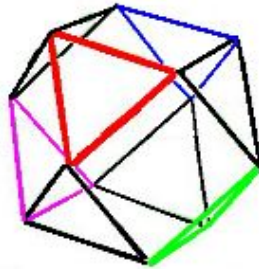
the 8 SU(3) Color Gluon Gauge Bosons are represented by the 8 corners of the two remaining back squares of Llull's S-wheel.

To see the Gravity and its 15 Gauge Bosons, look at Llull's T-wheel.



The 3 corners of the front T-triangle in Lull's T-wheel represent a 3-dimensional Cartan subalgebra of the 15-dimensional Conformal Group $SU(2,2) = Spin(2,4)$.

The 12 corners of the other 4 triangles in Lull's T-wheel represent the 12 vertices of the Cuboctahedron



Root Vector Polytope of the Conformal Group $SU(2,2) = Spin(2,4)$

The $3+12 = 15$ $SU(2,2) = Spin(2,4)$ Conformal Group GraviPhoton Gauge Bosons act on 4-dimensional Physical Spacetime by:

- -
 -
 -
 -
- 4 Translations,
- 6 Lorentz Transformations,
- 4 Special Conformal Transformations and
- 1 Dilation.

They produce Gravity through a generalized MacDowell-Mansouri mechanism.

Using the Lullian Structures, you can construct a Lagrangian over 4-dimensional Physical Spacetime that allows you to calculate:

- • Me-neutrino = Mmu-neutrino = Mtau-neutrino = 0 (tree-level)

- Higher-order corrections give:

- Mneutrino1 = 0

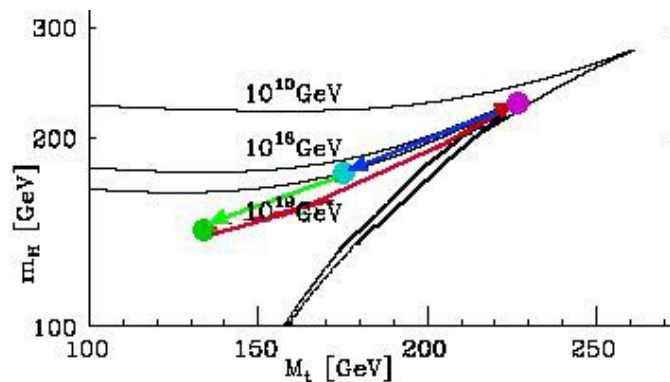
$$M_{\text{neutrino2}} = 9 \times 10^{-3} \text{ eV}$$

$$M_{\text{neutrino3}} = 5.4 \times 10^{-2} \text{ eV}$$

Neutrino mixing matrix:

	nu_1	nu_2	nu_3
nu_e	0.87	0.50	0
nu_m	-0.35	0.61	0.71
nu_t	0.35	-0.61	0.71

- • Me = 0.5110 MeV
- • Md = Mu = 312.8 MeV (constituent quark mass)
- • Mmu = 104.8 MeV
- • Ms = 625 MeV (constituent quark mass)
- • Mc = 2.09 GeV (constituent quark mass)
- • Mtau = 1.88 GeV
- • Mb = 5.63 GeV (constituent quark mass)
- • Mt = 130 GeV (constituent Truth Quark mass) as the ground state of a 3-state T-quark - Higgs - Triviality Boundary System



NJL state with Tquark mass = 130 GeV and Higgs mass = 146 GeV in the stable region far from the triviality and vacuum stability bounding curves and therefore closely related to other quarks in the stable region and therefore to single-Tquark events involving such things as T-Bbar events

8-dim Kaluza-Klein state with Tquark mass 172-175 GeV = and Higgs mass = 176-188 GeV, which state is closely related to the Higgs and T-Tbar condensates, and hence to T-Tbar events

BHL state with Tquark mass = 218 +/- 3 GeV and Higgs mass = 239 +/- 3 GeV at the Triviality Bound - Vacuum Stability Critical Point.

and

Kobayashi-Maskawa matrix:

	d	s	b
u	0.975	0.222	0.00249 -0.00388i
c	-0.222 -0.000161i	0.974 -0.0000365i	0.0423
t	0.00698 -0.00378i	-0.0418 -0.00086i	0.999

and

- • W+ mass = W- mass = 80.326 GeV
- • Z0 mass = 91.862 GeV
- • Higgs mass = 145.8 GeV
- • weak force - Higgs VEV = 252.5 GeV (assumed, since ratios are calculated)

as well as ratios of force strength constants:

- • Gravitational $G = (G_{\text{gravity}})(M_{\text{proton}})^2 = 5 \times 10^{(-39)}$ (assumed, since ratios are calculated)
- • electromagnetic fine structure constant = 1/137.03608
- • $G_{\text{fermi}} = (G_{\text{weak}})(M_{\text{proton}})^2 = 1.02 \times 10^{(-5)}$
- • color force strength = 0.6286 (at 0.245 GeV) - perturbative QCD running gives
- • color force strength = 0.167 (at 5.3 GeV)
- • color force strength = 0.121 (at 34 GeV)
- • color force strength = 0.106 (at 91 GeV)

If Nonperturbative QCD and other things are taken into account, then the color force strength = 0.123 (at 91 GeV).

Dark Energy : Dark Matter : Ordinary Matter

Ratio

0.75 : 0.21 : 0.04

(for details of the physics model and the calculations, and for references and source material, see my web site at www.valdostamuseum.org/hamsmith/ or mirror site at www.tony5m17h.net/ the contents of which are hereby incorporated herein by this parenthetical reference)

So, following Llull's path leads to a Unified Physics Model that meets Einstein's Criterion:

"... a theorem which at present can not be based upon anything more than upon a faith in the simplicity, i.e., intelligibility, of nature:

there are no arbitrary constants ...

that is to say,

nature is so constituted that it is possible logically to lay down such strongly determined laws that within these laws only rationally completely determined constants occur

(not constants, therefore, whose numerical value could be changed without destroying the theory). ..."

and

Ramon Llull was a Nexus between Ancient Wisdom and a Unified Model of 21st Century Physics.

His Lullian Wheels were only one of the ways by which he sought to transmit Ancient Wisdom to the People of his Future.

Within a century or two after Llull's death, his followers in what is now known as Italy produced the 78-card Tarot Deck of Cards.

Just as the practices of Divination had preserved in Africa

(and in the Mediterranean through 16-element Ilm al Raml,

and in China through the 64-element I Ching,

and in Japan through 128-element Futomani Book of Shinto Divination,

and in India through the $24+192 = 240$ -element First Sukt of the Rig Veda)

the Ancient Wisdom of the 256 Elements of IFA,

the 78-Card Tarot Game/Divination

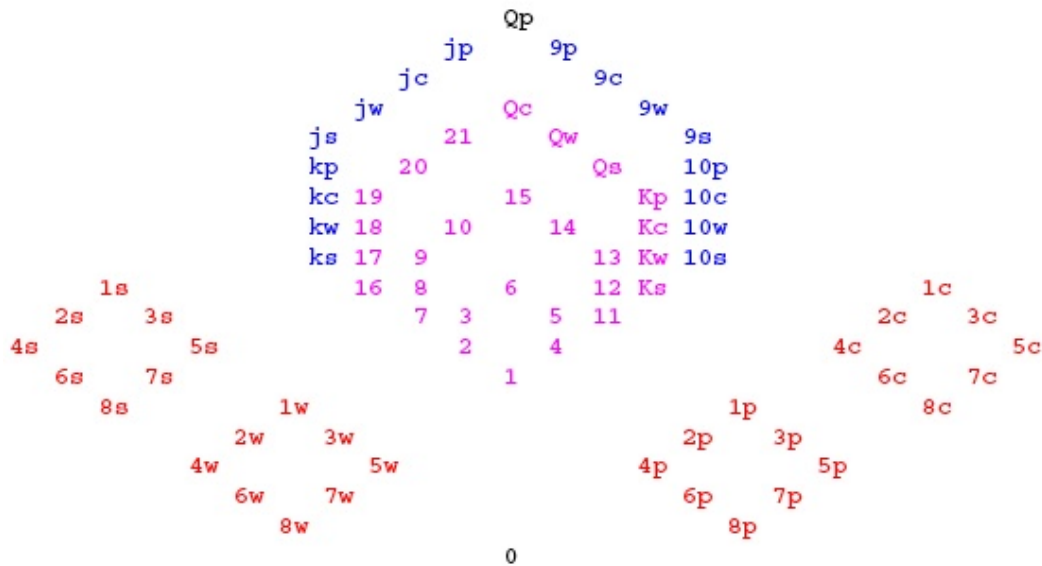
(and the common 52-Card Game Deck that descended from Tarot, which 52 Cards correspond to the 52-dimensional exceptional Lie Algebra F4 of which the 78-dimensional exceptional Lie Algebra E6 is a complexification)

would spread throughout the Global Society that began to be formed in the 1400-1500s and so preserve Fundamental Details of the Ancient Wisdom seen by Ramon Llull.

In this Tarot spread

(s=swords, w=wands, p=pentacles, c= cups and k=knave(page), j=Knight(Jack), K=King, Q=Queen, and

0=Fool, 1=Magician, 2=Popess, 3=Empress, 4=Emperor, 5=Pope, 6=Lovers, 7=Chariot, 8=Justice, 9=Hermit, 10=WheelofFate, 11=Strength, 12=HangedMan, 13=Death, 14=Temperance, 15=Devil, 16=Tower, 17=Star, 18=Moon, 19=Sun, 20=Judgment, 21=World)



- The 28 magenta 28 are the 28 Spin(8) adjoint bivectors of Cl(8).
- The 16 blue are the 8 vectors of Spin(8) and Cl(8) and their 8 dual/conjugates.
- The 32 red are the 16 spinors (8 +halfspinors and 8 -halfspinors) of Spin(8) and Cl(8) and their 16 dual/ conjugates.
- The 2 black are diagonal degrees of freedom in the 26-dim traceless J3(O)o part of the J3(O) Jordan algebra.

Considered all together, the 78 Tarot Cards correspond to the 78 elements of the exceptional Lie Algebra E6, which has a 5-graded structure with dimensionalities

$$8 + 16 + (28+1+1) + 16 + 8$$

that represents the Lullian Realistic Unified Physics Model.

If you regard strings as world-lines of particles in the Quantum Path Integral Sum-Over-Histories in the Many-Worlds, then an E6 String Theory produces a generalized Bohm Quantum Potential, with Sarfatti-type Back-Reaction, that is useful in describing Penrose-Hameroff Quantum Consciousness.

In acting as a Nexus connecting Ancient Wisdom with 21st Century Physics,

Ramon Llull expressed what Einstein (in the New York Times Magazine on November 9, 1930 pp 1-4) called cosmic religious feeling:

"... It is very difficult to elucidate ... cosmic religious feeling ... to anyone who is entirely without it ...

The individual feels the futility of human desires and aims and the sublimity and marvelous order which reveal themselves both in nature and in the world of thought.

Individual existence impresses him as a sort of prison and he wants to experience the universe as a single significant whole.

... the cosmic religious feeling is the strongest and noblest motive for scientific research.

What a deep conviction of the rationality of the universe and what a yearning to understand ... Kepler and Newton must have had to enable them to spend years of solitary labor in disentangling the principles of

celestial mechanics!

Those whose acquaintance with scientific research is derived chiefly from its practical results easily develop a completely false notion of the mentality of the men who, surrounded by a skeptical world, have shown the way to kindred spirits scattered wide through the world and through the centuries. ...

It is cosmic religious feeling that gives a man such strength. ...".

Frank Dodd (Tony) Smith, Jr.

April 2007

(for further material and details, and for references and source material, see my web site at www.valdostamuseum.org/hamsmith/ or mirror site at www.tony5m17h.net/ the contents of which are hereby incorporated herein by this parenthetical reference)
