Theory versus Design of the World

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Consider that the design of the world is Complex Octonion algebra, an idea which I heard at a lecture in 1966, in high school. The opening remark was that it is a bit odd that Quantum Mechanics does not define quanta, and is almost entirely about Mechanics, and one would like to 'enumerate quanta as duality oscillators – generalizing photons'. Does this idea survive in spite of the enormous advances since ElectroWeak and QCD ?

Octonions recover Peano's axioms of ordinary arithmetic, being anti-associating and anti-commuting, which cancel out for the real and complex subalgebras. Physics seems to ignore this as a requirement.

What is the bare minimum that Nature needs to crank out the universe ? If it is the design of the world, it should define space and particles. Since it includes quaternions we should have no problem with 3-space. Then octonions ought to define particles. That provides some basis to consider the Design of the World. This is not the same as a Theory of Everything. One would like to know whether it stands a reasonable chance, before investing a lot of time.

The appendix lists all the ways to permute and associate four letters, to get a basic set of 120 Duality Oscillators – pairing vertex-face or edge-edge. Double that because we have opposite signatures, and double it again because we can exchange vertices and faces. Now we have 480 of these things. It appears to be a complete set.

Parentheses get in the way of a spacetime multivector interpretation, however it does look respectably 'tetrahedral' , but (oa)(bc) is just one pair of edges out of six edges – sort of a Cheshire tetrahedron.

There are some amusing features which appear automatically:

* Non-associativity has to do with defining particles as duality oscillators, rather than the behavior of particles in space.

* Who asked for Minkowski signatures ? A pair of opposite signatures, so every oscillator has an anti-oscillator.

* With 16 components, we always get either **+---** or **-+++ .**
There is no **++++** or **----** or **++--**.
* There is Generation Structure thanks to **+---, -+--, --+-, ---+**
we just put (o) in slot 0,1,2,3. Notice that generations are not really copies.

* All these tetrahedral things are compatible with three dimensional space, and have a complex phase 1 + o(a(bc)) etc – like Feynman's spinning stopwatch.

But there is no Hamiltonian here – no mention of position or momentum. So, there is no Physics here, yet it looks like aspects of particles !

There are 5 associations – but only two of them look like familiar leptons and quarks: an anti-commuting exchange stays in the same generation. All the others would change generation on exchange because they contain (oa). That might have interesting connections to both Mixing and Dark Matter.

* Signature reversal has curious differences in where the octonion and quaternion division subalgebras appear in a frame, which might be relevant to why there isn't an equal number of particles and anti-particles in the universe.

* There are 'associations' all around us. Any atom is like an 'experimental situation' and one might wonder if the 'physical constants' are given, or does the algebra require neutral constructions of building block a priori, and the physical constants must be what they are in order to get the constructions ? In that case we can do away with questions about why the Constants are what they are.

How would we consider Occam's Razor in this context ? The table in the Appendix suggests a lot of 'particles' that are not in the Standard Model. Factoring out Color and Spin and anti-matter, since they have the same mass, one gets 480/12 = 40 oscillators, 10 in each generation. The SM sees four of these: electron and neutrino types, and up and down quark types. Are the remaining six some kind of Dark Matter ? I call them Kooks, Goblins and Gremlins. They appear to have color, but is it the same color as the massless spin-1 bosons of QCD ? If so, they would interact with SM fermions in a gluon plasma.
If one is a devotee of Occam, it all looks rather extravagant. But those 'dark oscillators' all involve generation changes if we do oa = -ao, etc. Anything with

generation changing suggests something to do with Mixing Matrices, and that suggests something like a field, rather than just particles to explain galactic structure formation.

Note that algebra appears silent on the subjects of mass or charge. This means it has a nontrivial relationship to physics.

The Philosophical Issues:

Of course math is going to be unreasonably effective in physics. Hamilton's discovery of quaternion algebra revolutionized Newtonian physics. Extending that to Octonions runs into a problem of dealing with particles – we can not inspect particles to verify or falsify their connection to algebra. So there is a long and winding road to make sense of particles. Are particles actually irreducible representations of the Poincare group ? How does that explain muons ? There is more going on than mass and spin. And there is a distinction between accommodating facts and explaining them.
It would be a lot more 'unreasonably effective' if we could read off everything by inspection ! I remember a remark that someone thought this whole idea would be useless in physics because one would have to know everything in order to know anything. The Design of the World is not an answer, it is a mystery.

Why does the physical world obey some laws and not others ?
Is the issue the laws, meaning the behavior of particles ?
Why are 'laws' the issue when we know that generations of fermions make no sense ? That is a structural issue.

Are we missing interesting theories because we are committed to particular mathematical frameworks, or suitable ones have not been developed ?

The Standard Model is committed to the Yang-Mills approach, and does very well with experiment and description. We look at the world through Lagrangians and local gauge theory on Lie groups. But it seems so open ended. One wonders why *these* Lie groups. The world is *not* "mathematical" in some open ended sense. It is a very specific system.

APPENDIX – duality oscillators in Generations.

generation 0 where the o is in slot 0 . (possibly bosons)

???	???			
o(a(bc))	o((ab)c)	(oa)(bc)	(o(ab))c	((oa)b)c
o(a(cb))	o((ac)b)	(oa)(cb)	(o(ac))b	((oa)c)b
o(b(ac))	o((ba)c)	(ob)(ac)	(o(ba))c	((ob)a)c
o(b(ca))	o((bc)a)	(ob)(ca)	(o(bc))a	((ob)c)a
o(c(ab))	o((ca)b)	(oc)(ab)	(o(ca))b	((oc)a)b
o(c(ba))	o((cb)a)	(oc)(ba)	(o(cb))a	((oc)b)a

generation 1 o in slot 1

quarks	kooks	leptons	goblins	gremlins
a(o(bc))	a((ob)c)	(ao)(bc)	(a(ob))c	((ao)b)c
a(o(cb))	a((oc)b)	(ao)(cb)	(a(oc))b	((ao)c)b
b(o(ac))	b((oa)c)	(bo)(ac)	(b(oa))c	((bo)a)c
b(o(ca))	b((oc)a)	(bo)(ca)	(b(oc))a	((bo)c)a
c(o(ab))	c((oa)b)	(co)(ab)	(c(oa))b	((co)a)b
c(o(ba))	c((ob)a)	(co)(ba)	(c(ob))a	((co)b)a

generation 2 o in slot 2

		leptons	kooks	quarks
a(b(oc))	a((bo)c)	(ab)(oc)	(a(bo))c	((ab)o)c
a(c(ob))	a((co)b)	(ac)(ob)	(a(co))b	((ac)o)b
b(a(oc))	b((ao)c)	(ba)(oc)	(b(ao))c	((ba)o)c
b(c(oa))	b((co)a)	(bc)(oa)	(b(co))a	((bc)o)a
c(a(ob))	c((ao)b)	(ca)(ob)	(c(ao))b	((ca)o)b
c(b(oa))	c((bo)a)	(cb)(oa)	(c(bo))a	((cb)o)a

generation 3 o in slot 3

kooks	quarks	leptons	???	???
a(b(co))	a((bc)o)	(ab)(co)	(a(bc))o	((ab)c)o
a(c(bo))	a((cb)o)	(ac)(bo)	(a(cb))o	((ac)b)o
b(c(ao))	b((ca)o)	(bc)(ao)	(b(ca))o	((bc)a)o
b(a(co))	b((ac)o)	(ba)(co)	(b(ac))o	((ba)c)o
c(a(bo))	c((ab)o)	(ca)(bo)	(c(ab))o	((ca)b)o
c(b(ao))	c((ba)o)	(cb)(ao)	(c(ba))o	((cb)a)o

There are 4 such tables

- one for +--- generated by vertices
- one for +--- generated by faces
- one for -+++ generated by vertices
- one for -+++ generated by faces