Chapter 10
Epilogue

In conclusion it is necessary to point out that the purpose of this essay has not been to belittle the efforts of the quantum pioneers, but to caution against the construction of scientific theories by acclaim. By constant probing it is possible to expose possible flaws, even in the most reputable theory. That is the easy part.

Equally easy, is to add secondary weak assumptions to mask any defect, followed by another if necessary, and another ... The end product is a house of cards. The quantum theory of chemistry has reached the point, by following this procedure, where it is stated with serious conviction that "in the case of hybrid orbitals quantum numbers are not needed any more".

The more daunting approach is to challenge any flawed idea, even of the most respected authority. This is what scientists of the Enlightenment had to do with Aristotle's physics, what Copernicus and Galileo did to Ptolemaic cosmology, and what Lavoisier had to do about the phlogiston theory. In retrospect such actions are hailed as heroic, but in real time they caused endless animosity. Lavoisier ended up on the guillotine.

In the present instance understanding of the criticism against quantum theory is growing, but tempered by widespread reluctance to abandon a respected paradigm. A common response is that concepts such as sp^2 interaction have become part of chemical language and should therefore be retained without the orbital connotation. This is dangerous and unacceptable. It is argued that simulation by DFT methods produces useful results and should continue as part of *computational chemistry*, without invoking quantum theory. Fact is, that the methodology relies on expendable complications, inspired by suspect procedures, such as linear superposition, once considered essential as quantum techniques, but no longer valid.

Another respondent, focussed on career prospects in relation to research output, could see no benefit in switching to comparatively untried methods, and working without reliable software. To call this a mercenary attitude may be too harsh, but it is unscientific.

Others despair over giving up a user-friendly comfort zone in favour of obscure unfamiliar concepts such as space-time curvature, hypercomplex algebra,

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self-similar symmetry, logarithmic spirals, gauge invariance and other outlandish things. These critics should remember how, at the time when Heisenberg announced the basis of quantum mechanics, he had never heard of a mathematical matrix, the concept that made him famous. To soften the blow the discussion is concluded by a brief summary of a logical argument that leads from ordinary common sense to a useful re-appraisal of physical science, that presumably avoids the illogical features of quantum mechanics, the gamble that never paid off.

On the paper trail through Tesla's utterances one encounters a statement that explains the widespread scepticism about the theory of relativity. He states [1]:

> I hold that space cannot be curved, for the simple reason that it can have no properties. It might as well be said that God has properties. He has not, but only attributes and these are of our own making. Of properties we can only speak when dealing with matter filling the space. To say that in the presence of large bodies space becomes curved, is equivalent to stating that something can act upon nothing.

In this instance it is not a question of *clear vs deep* thinking, but a simple matter of careless terminology.

To put the record straight, consider a finite four-dimensional physical aether, which is closed and therefore curved. It curves through an involution into a shape, topologically best described as the double cover of a projective plane. The interface is a vacuum devoid of all matter, which is concentrated as standing waves in the double cover. The interface is pervaded by achiral bosonic fields, with all fermions in the chiral double cover.

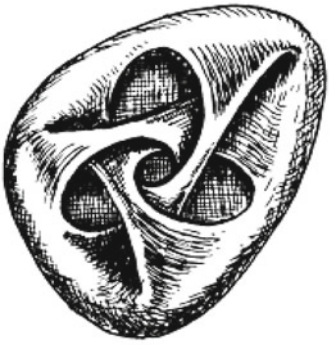
To account for the reciprocity between matter and curvature postulated by general relativity, it may be assumed that should the aether be flattened out into an infinite Euclidean plane it becomes completely featureless. All irregularities, recognized as matter and energy, as well as the interface, would disappear into a void. Without agonizing over the origin of the universe or the development of its assumed structure it is sufficient to postulate a balanced system in dynamic equilibrium. Popular arguments about the miraculous fine-tuning of physical constants serve no purpose.

A useful axiom is to assume that the stability and properties of the cosmos depend on its size. The state of equilibrium must be commensurate with maximum stability and optimal size. This way a unique cosmic structure is implied.

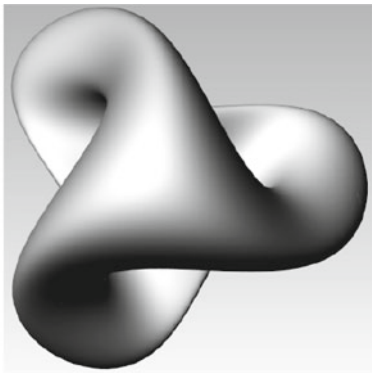
In this state all vital parameters are in fixed relationship, leaving no room for speculation about slightly different fine-structure constants or the speed of light. In its closed equilibrium state the size and curvature of the cosmos are invariant and in harmony with all properties that depend on these. 'Mysterious' fine-tuning goes together with the existence of the universe and leaves no room for teleological speculation. The only task of the cosmologist is to measure and interpret the parameters, characteristic of the observed structure.

One possible strategy is to postulate a trial structure for validation against all conceivable observations. The current investigation postulates a universe, closed with the topology of a real projective plane and general curvature to match a golden logarithmic spiral. Visualization of this four-dimensional structure, in the form of a

Boy's Surface



Flat view



Round view

three-dimensional shadow [2], is known as a Boy surface; it cuts through itself but has the advantage of having no singular points.

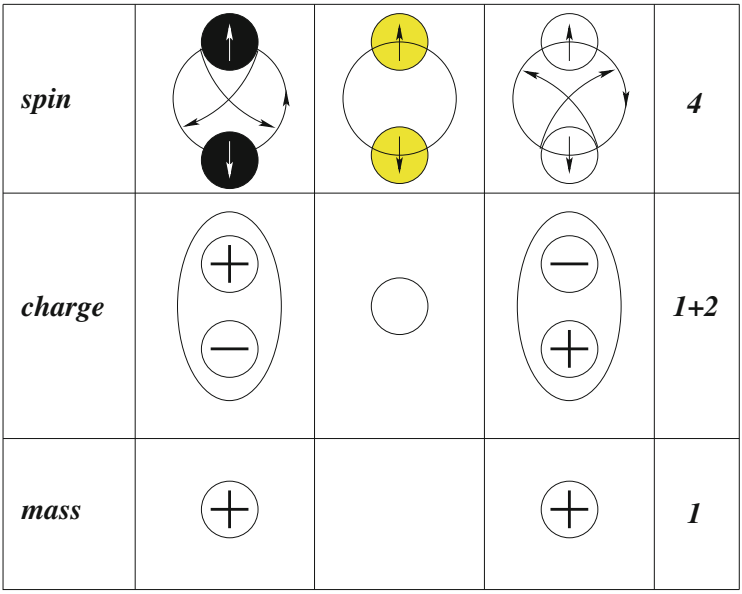
The immediate consequences are cyclic variation of space and time, finite size of the universe, self-similar symmetry throughout the cosmos, effective separation of matter and antimatter, increased distortion at long range of observations interpreted in tangent space, and the necessity to reconsider all cosmological models.

The most important consideration is that cosmic models should be consistent with mathematical practice, the most important of which is to be free of singularities. This is where standard cosmology is woefully inadequate. The entire edifice is based on the most glaring of singularities and stretches into an undefined infinity. It is littered with countless black-hole singularities and despite its infinite extent has no room for antimatter. The hogwash about naked and hidden singularities confuses rather than enlightens the argument. It simply has no credible mathematical basis.

The projective structure proposed here, does not lead to any known singularities. Black-hole singularity is eliminated by allowing discharge of infinitely dense matter through the cosmic interface. For each black hole there is an antipodal white hole. It is significant to note that the assumed double cover is in perfect register with octonion algebra as indicated before. At the same time analysis of the group operations on the projective plane has been shown [3] to be equivalent to quaternion multiplication.

The proposal of four-dimensional matter waves with spin, charge and mass is in line with both geometrical and algebraic demands of the assumed topology. All of the symmetries needed by particle physicists to balance the books, are the normal modes of four-dimensional waves in $2 \times 4 = 1 + 7$ dimensions of octonion algebra.

The re-interpretation of non-classical effects in terms of wave phenomena has serious implications beyond theoretical chemistry and physics. One of the most profound, concerns the physical size of the universe, seen as a closed rather than an infinite Euclidean structure. Another look at Boy's perception of a projective surface



affirms a huge difference between such an environment and the impression it makes on a casual observer in tangent space. A likely image is sketched by Luminet [4]:

> ⋯ consider a room paneled with mirrors on all six surfaces (including the floor and the ceiling) ⋯ the interplay of multiple reflections will immediately cause ⋯ the impression of seeing infinitely far in every direction. Cosmic space, which is seemingly gigantic, might be lulling us with a similar illusion.

To be surrounded by a hollow spherical mirror would be even more confusing. Projective space-time that curves like a golden spiral also enhances the confusion because of self-similar symmetry and the lack of a large-scale metric. It is not inconceivable that the images of the night sky are all generated by projective distortion of local four-dimensional effects within the milky way, which itself may appear inflated in size. As cautioned by Luminet [4]:

> Treating ⋯ global aspects of space requires a mixture of advanced mathematics and subtle cosmological interpretations.

As experimental evidence of a universe, restricted in size, he [4] refers to missing long wavelengths in the cosmic microwave background and argues that the universe is simply too small to sustain such wavelengths.

Another word of caution: the so-called ‘concordance’ model adhered to by modern cosmologists considers the topology of space as strictly independent of time. A space-time model would certainly require mathematics, even more advanced, and cosmological observations, more subtle, than currently contemplated. It is safe to conclude that the size of the cosmos is completely unknown. Jumping

to conclusions would be like theorizing without data; running the risk of arriving at mysterious conclusions like those of pioneer quantum mechanics.

The ultimate aim of twentieth century quantum theory was to explain the nature of matter and its interaction with radiation. The latter issue has been explored in mathematical detail as the science of spectroscopy. The success of this venture was ensured by the analysis of all interactions in terms of a simple wave theory. At all levels, from the atomic, through the molecular, to solid and plasma states, the interaction only considers the frequency of radiation and relevant electronic energy levels. The physical structure of the electrons remains unspecified.

It is only when the theory is extended to analyze the physical nature of matter in terms of quantum particles, that it tends to fall apart. As a seminal assumption it is accepted that particles of elementary matter occur in a void. The nature of the particles are, in the first instance, only known from empirical observation and mathematical details of the behaviour are modelled to fit. The derived interaction parameters appear to be delicately fine-tuned by chance, in a process that miraculously favours one out of an infinite variety of possible universes.

Interactions at the sub-atomic level, which appear to be decidedly non-classical, are controlled by probability waves that resonate with human consciousness in order to create physical matter from virtual particles in the vacuum. Apparently there is no void after all.

This, in a nutshell, is quantum field theory. It is rather awkward to describe it in the subtle detail it deserves without an exposition of probability-wave theory and the nature of virtual particles. However, as pointed out by Feynman, these considerations are too deep for mortal understanding; hence items of dogmatic belief?

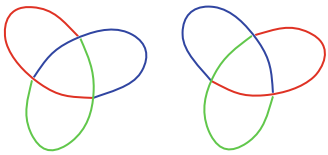
The legacy of QFT is the dream of unlimited free energy, waiting to be extracted from the vacuum, actively pursued by countless amateurs. The concept is traced back to the Dirac sea that postulates the existence of an infinite number of quantum states occupied by antimatter in the vacuum. In QFT each of these states is associated with a virtual particle, mathematically described by a harmonic quantum oscillator that carries half a quantum of zero-point energy.

Hopefully the reader may find the alternative wave theory more digestible. As hinted before, it is based on the existence of an aether with physical properties. In a hypothetical Euclidean state it resembles a liquid in laminar flow. Any geometrical distortion produces turbulence, vortices, eddies and other nonlinear deformations. In a closed topology such disturbances will be of a periodic nature and, in line with special relativity, best described as four-dimensional standing waves.

All of these waves must carry the property of fermionic spin. One type of wave could be longitudinal, corresponding to penetrative neutral matter such as neutrinos. In vacuum physics, neutrino radiation is called zero-point radiation. In cosmology it is known as cosmic background radiation. Other varieties could be of a transverse nature that imparts electric charge. The simplest type of leptonic wave has a single transverse component, whereas more complicated baryonic waves have three components.

The typical lepton is an electron that carries a negative charge. The proposed baryonic structure is reminiscent of the quark model as derived from the study of symmetry groups. The proposed wave structure explains why free quarks are never observed.

The wave structure proposed for baryons is described topologically as a trefoil knot, the simplest non-trivial knot. It has a chiral structure, closely related to that of Boy's surface, but is invertible.



This property allows for the definition of an antibaryon as well as a baryon with inverted spin. The trefoil knot is also tricoularable, the property that may have inspired the theory of QCD.

In a projective double cover, chiral waves transform into anti-wave forms of opposite chirality as they progress through the projective involution. All waves acquire mass to a larger or lesser extent by virtue of their intrinsic nonlinear environment. When localized into a non-dispersive shape, the mass centre moves at speeds less than that of light.

The speed of light is realized only in the achiral interface between matter and antimatter. Only bosonic standing waves occur in this interface which is truly void. As the medium of communication between emitters and acceptors, these waves transmit radiant energy at the speed of light. Constrained within the interface electromagnetic radiation has only two transverse components of vibration.

All of the proposed forms of elementary wave are routinely observed as cosmic rays, including neutrinos. Apparent stellar sources are no more than secondary sources. The preponderance of these waves, which occur at a sub-critical level, are a manifestation of space-time curvature. Should their concentration exceed the critical level, that depends on the degree of curvature, more complex aggregate forms of matter are formed.

Aggregation of elementary matter does not produce atomic matter more complex than neutrons, hydrogen and helium, but this is sufficient to generate clouds that condense under gravity and collapse into stars, galaxies and black holes. The genesis of ponderable matter is briefly outlined in Appendix E. Black holes are responsible for the synthesis of heavy nuclei which are dispersed through Einstein-Rosen bridges across the vacuum interface. Excess matter is exchanged by this mechanism, resulting in cosmic equilibrium.

An unused quantity of elementary matter remains dispersed through the universe, slowly building up into interstellar clouds by combining with cosmic dust and debris. In turn, this process results in the formation of new stars and galaxies. Matter and antimatter remain effectively separated by the interface and prevented from

interacting by virtue of inverted time directions. The second law of thermodynamics is balanced across the interface and the universal entropy remains at zero. There is neither heat-death nor big-bang birth and the cosmos remains in well-balanced equilibrium.

Intuitively aware of such equilibrium the search for a unification of the gravitational and electromagnetic fields became an early priority. The first unsuccessful crack by Weyl, by way of a gauge principle, later succeeded in terms of a complex phase. In this form it found application in the formulation of classical electrodynamics and the modern theory of elementary-particle physics. A convincing mathematical elucidation of gauge phenomena was provided only recently [5]. The theory developed by these authors is summarized well in their own words from the Abstract:

> Usually Maxwell's equations are invariant with respect to a gauge transformation of the potentials and one can choose freely a gauge condition. For instance, the Lorentz gauge condition yields the potential Lorentz inhomogeneous equations. It is possible to introduce a scalar field in the Maxwell equations such that the generalised Maxwell theory, expressed in terms of the potentials, automatically satisfy the Lorentz inhomogeneous wave equations, without any gauge condition. This theory of electrodynamics is no longer gauge invariant with respect to a transformation of the potentials: it is electrodynamics with broken gauge symmetry.

The essence of their theory is outlined in the Conclusions:

> It is possible to describe classical electrodynamics in the form of two biquaternion equations. This form is very useful in order to generalise electrodynamics. Generalising the Maxwell equation by introducing an extra scalar field is comparable with Maxwell's introduction of the displacement current that allowed for the derivation of the homogeneous field wave equations.

The biquaternion that they mention, is the same as an octonion, recognized before as a descriptor of a projective double cover in eight dimensions. This is independent confirmation of the proposal to relate gauge phenomena directly to projective geometry. As a potential consequence the authors [5] mention a possible 'classical theory of photon tunneling', which also resonates with the topological effects on a field in four-dimensional curved space-time.

It is worth repeating the result discussed in Chap. 4 of how projective relativity finally demonstrated the unification of the electromagnetic and gravitational fields. Gravity is a simple manifestation of space-time curvature, but electromagnetism is sensitive to a gauge factor. In projective space-time the gauge field is fixed topologically and the field equations of projective relativity hence refer to unified fields. The demonstration that the extra parameters correctly describe the electromagnetic field is achieved by transformation to tangent space, resulting in the relativistic Klein-Gordon wave equation. Transformation of the electromagnetic potentials is mediated by the golden ratio.

Most of the matter in the universe is in the plasma state. Complex inorganic matter is largely confined to planets with metallic or rocky cores, enveloped by liquid or gaseous clouds. Organic matter occurs on fewer planets and to a lesser degree in interstellar dust. The chemical interactions that result in the formation of

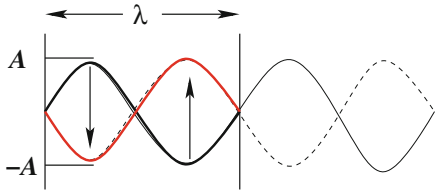
complex forms of matter are adequately explained as the interference of electron waves.

At the end of this odyssey it is fair to ask:

"Exactly what did Max Planck discover?"

According to his own account it was that a discrete function relates the energy of a standing wave to its frequency. In symbols $E = (nh)\nu$, where h is a constant and n an integer. The constant has dimensions of energy×time, called *action*. Black-body radiation therefore teaches that the action of a standing wave is an integral multiple of an elementary unit.

A standing wave has a fixed length and oscillates between displacements of A and $-A$, as shown. Each vibrating unit of wavelength λ stores an amount of energy $E = hc/\lambda = h\nu$. Over one period of oscillation, $\tau = 1/\nu$, the unit of action, $E\tau = h$. The total action of a standing wave, stretching over n wavelengths, is nh and the energy, $E = nh\nu$, often ascribed to n photons.



In four-dimensional space-time one unit of action represents 2π units of spin. This means that what Planck discovered was the spin of standing waves, which indeed is the property that distinguishes non-classical waves from their three-dimensional counterparts.

The momentous discovery of electron diffraction should have put the nature of all matter in proper perspective, but by then Bohr's quantum theory of the atom had already entrenched the particle model of the electron. Schrödinger's linear wave equation caused even more confusion, which can only be undone by an equation in four-dimensional nonlinear spinors.

At this point the Copenhagen story is history. What remains are electromagnetic waves together with three types of matter wave corresponding to neutrinos, electrons and protons. The former propagate through the vacuum in the projective interface at the speed of light, not impeded by any aether drag. A word of caution is in order at this point. The concept of speed cannot be generalized into Minkowski space-time and has operational meaning only in a three-dimensional world. Propagation in the vacuum interface is best described in terms of standing waves. Nonlinear matter waves are in the aether with de Broglie wavelength of h/mv and variable velocity $v < c$, which depends on the local environment. The wavelength adapts to increasing nonlinearity until the wave breaks up into individual solitons that move through the aether without getting entangled, by virtue of their spherical spin.

As the concentration of elementary matter waves reaches super-critical levels, atomic matter is formed by the following interactions:

$$p^+ + e^- + \nu \rightarrow n$$
$$p^+ + e^- \rightarrow \mathrm{H}$$
$$2p^+ + 2n \rightarrow \alpha^{2+}$$
$$\alpha^{2+} + 2e^- \rightarrow \mathrm{He}$$

Under conditions of extreme gravity the chemical elements are synthesized by the fusion of α particles [6]. As the nuclides pour out from a synthetic black hole into more rarefied intergalactic space, they become less stable and many of them disintegrate completely. The 264 stable isotopes of 81 elements that occur in the solar system are readily demonstrated to be adapted to the space-time curvature characteristic of a golden logarithmic spiral. Not only nuclide stability but the variation of all chemical properties are faithfully modelled by golden-spiral optimization and elementary number theory.

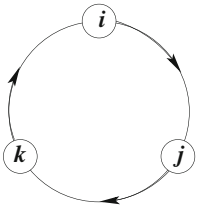
The prospect of formulating a new theory for chemistry with minimal reference to traditional quantum mechanics appears to be bright. As a theory of chemistry, the quantum gamble has not paid off and the other sciences should take note.

Apart from the quantum of action the concepts that feature most prominently in this work are normed division algebras and projective geometry. In concluding the argument it is appropriate to mention the close relationship that exists between these concepts.

In terms of the complex pair $u = a + ib$ and $v = c + id$ the quaternion is defined as

$$q = a + ib + jc + kd \; ; \; q = a_0 + a_i e_i$$

with the rule of composition: $i^2 = j^2 = k^2 = ijk = -1$, summarized graphically by the cyclic triplet shown below.

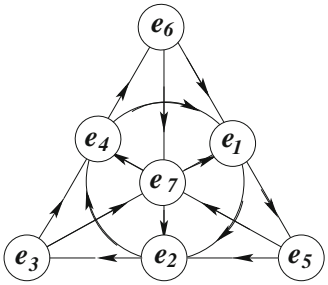


Multiplication of two elements going clockwise produces the next one, e.g. $ij = k$. The product going anticlockwise is $ji = -k$.

By extending the process of dimension doubling to a pair of quaternions an 8-dimensional non-associative division algebra of octonions, of the form

$a_0 + \sum_{i=1}^{7} a_i e_i$ for all a_i real, is produced. The rule of multiplication is summarized by the following *Fano plane*, which consists of 7 points and 7 directed lines, counting the central circle as a line.

Each pair of points lies on a unique line. Each line contains three points and each of these triplets has a cyclic ordering shown by the arrows. In cyclic order $e_i e_j = e_k$; $e_j e_i = -e_k$, $e_i^2 + e_j^2 + e_k^2 = -1$, a precise copy of the two quaternions within the octonion, $e_1 - e_2 - e_4$ and $e_3 - e_6 - e_5$.



All other properties of division algebras are satisfied. The superimposed pair of quaternions represent a left- and right-handed pair of spinors. The Fano plane also represents the double cover of the projective plane over a two-element field of integers [7], which becomes important in the definition of antimatter. It also represents the projective plane with the fewest points and lines. Any pair of lines intersect in only one point.

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