

2016

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Suppressed Intuitions, Large Number Coincidences, and a Mathematical Foundation for Life and Consciousness

Maurice Goodman

ABSTRACT

A brief examination of the natural sciences reveals that we are still under the influence of pre Copernican intuitions. These have only been suppressed and not supplanted. This is why we appeal to such things as large number coincidences in the hope that the mathematics, which unlike us does not suffer from naive beliefs, will lead us in the right direction. However, we need to be extremely careful as it is easy to create these coincidences and over interpret their significance. In the 1980's work on these coincidences did lead to a mathematical formalism which seems to have relevance in our universe. This led to a suggested link between the biological cell, the weak force and the electron neutrino and suggests a new approach to consciousness studies that is gradually gaining ground. The mathematical formalism also suggests a new arrangement for the natural sciences which is more appropriate in a post Copernican world.

Key Words: natural science, large number coincidences, uncertainty principle, electron neutrino, weak force, biological cell, consciousness

DOI Number: 10.14704/nq.2016.14.1.890

NeuroQuantology 2016; 1: 62-67

1. Introduction

The front cover of the March (2015) edition of *National Geographic* proclaims that there is a "war on science". In a related article in that issue Joel Achenbach (2015) points to our intuitions, and the realization that scientific knowledge only suppresses but does not supplant earlier intuitions (Shtulman *et al.*, 2012), as the cause of this war. This means that these old intuitions are still there deep in our subconscious mind and are the source of this continual confrontation. That, in turn, raises the question as to whether earlier intuitions, long since discredited, are still influencing how we view science today.

Before Copernicus we believed: (1) that the earth was the centre of the universe and (2)

that human beings were the most significant species at that centre (Anthropocentrism). After 500 years are these discredited intuitions influencing how we currently view science? Below, in Figure 1, you can see how we arrange the fundamental natural sciences to this day.

The first thing to notice is we still consider earth science to be one of the five fundamental natural sciences (belief-1 suppressed) despite the fact that there are tens of billions of earth like planets orbiting at earth like distances around sun like stars in our galaxy. It, in turn, is only one of billions of galaxies in our universe. In summary, earth science is a natural science but it is not fundamental.

More significantly, without good reason we divide the natural sciences into two main branches, life (biology) and physical. This suggests that life science is somehow special (belief-2 suppressed) and is not physical (of matter) even though biological structures are clearly made of matter. The effect of this is to cut

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Received: 24 November 2015; **Accepted:** 16 January 2016

eISSN 1303-5150



life science off from any physical or mathematical underpinning which is preventing progress in a whole host of life sciences from cell biology to consciousness studies (Goodman, 2015). A mathematical and physical underpinning must be found so that theories supporting these sciences are built on solid mathematical foundations instead of relying on discredited intuitions and baseless conjecture. The motivation for looking at large number coincidences is to provide a mathematical foundation for, not just the life sciences but, all the natural sciences, structures, particles and forces in our universe.

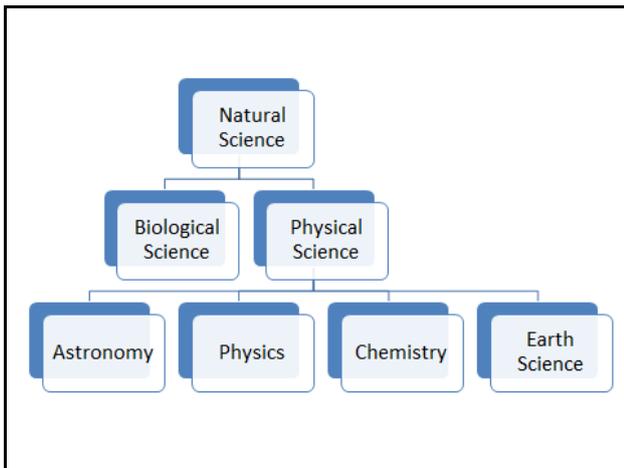


Figure 1. Current arrangement of the fundamental natural sciences.

2. Large Number Coincidences

A recent paper in this journal (Roy *et al.*, 2015) wondered if Dirac’s large number hypothesis could be related to consciousness as the ratio of the time scale of 40Hz oscillation in neuronal systems in the brain and the Planck time was 10^{40} like other large number ratios found in nature.

Large number coincidences began with Hermann Weyl (1919) and were taken up by Arthur Eddington (1931). Our intuition tells us that the reoccurrence of large numbers of similar size in nature must point to some underlying physical or mathematical principle. In 1980 my intuition told me this must be the case also and I was bewitched by these coincidences. However, such intuitions can be right or wrong so much care and experimental verification is needed before any conclusion can be arrived at. These large number coincidences are what prompted Paul Dirac to write a short letter to Nature (1937) proposing the large number hypothesis in the first place. This hypothesis became very

influential in the first half of the twentieth century because it intuitively seemed reasonable. However, the hypothesis is not yet proven and hence it would be unwise to use it as a basis for building a theory of consciousness.

Also it must be remembered that when this hypothesis was being developed only two of the four forces of nature were known. This meant only one possible ratio could exist between “large” gravitational structures and “small” electromagnetic structures and therefore this hypothesis only included the known natural sciences of Astronomy and Chemistry. It is a minimum requirement that any valid hypothesis developed from such coincidences must apply to all four forces of nature. In summary, we need to be extremely careful when considering old unproven hypotheses and attaching significance to any such ratios found in nature.

Following from this, the appearance of a ratio of 10^{40} between 40 Hz oscillations in the brain and the Planck time is not in itself significant. It is easy to create these ratios. For example, the following ratios are also all approximately equal to 10^{40} :

$$\frac{M_{star}}{M_{pl}} \approx \frac{R_{Ceres}}{R_{pl}} \approx \frac{M_{elephant}}{M_{neutrino}}$$

where M is mass and R is size. Ceres is the largest asteroid in our solar system, M_{pl} and R_{pl} is Planck mass and length respectively and $M_{neutrino}$ is the soon to be measured electron neutrino mass which is $\sim 10^{-37}$ kg. However, none of these ratios are likely to have much significance either.

It is even easier to over interpret the significance of these ratios. For example, any ratios that involve Planck mass, length or time intuitively leads to the association of that ratio with the gravitational force and quantum gravity. This is because the gravitational constant (G) forms a part of all three Planck parameters. It is what, I believe, happened to Hameroff and Penrose (1996) whose need for quantum non-computability in consciousness was at the base of their reasoning. Appealing to the Planck scale, and hence gravity, was the only conceivable way, at that time, to draw quantum mechanics into a non-computable model of conscious thought. This, I believe, is also happening in the paper of

Roy et al. (2015). In their conclusion they have already stated that there is a need to study the effect of gravity on synchronized oscillations in the brain. That does not logically follow from what appears to be just another arbitrary ratio involving the Planck time and hence gravity.

The main problem with such an association with brain processes and consciousness is that the length and time scales associated with the Planck parameters that characterize quantum gravity are 10^{-33} m and 10^{-43} s respectively. These are way too small to be associated with the relevant dynamical scales in brain processes either from a multicellular dimensional ($>10^{-5}$ m.) or millisecond time scale perspective.

However, it is still a legitimate question to ask if there is any significance to these ratios and more importantly do these coincidences lead to new ideas that can be applied to the universe as a whole i.e. not just two but all four forces in the universe and all structures found in the universe and maybe ultimately to life itself. This idea was explored in detail during the 1980's and the findings published, against a background of substantial resistance (Goodman, 2001) from mainstream science journals, in the 1990's (Goodman, 1994; 1997) and a brief summary is given here.

3. Maths underpinning large number ratios

The large number coincidences formulated by Eddington that attracted Dirac's (1937) attention were the ratio of the electric (F_E) to gravitational (F_G) forces, between a proton and electron, and the ratio of the mass of the universe M_U to the mass of a proton M_P which happened to be the square of the first ratio. These ratios are also equal the ratio of the radius of the Universe R_U to the radius of the proton, R_P . That is:

$$\sqrt[2]{M_U/M_P} \cong R_U/R_P \cong F_E/F_G \quad \text{eqn. (1)}$$

The question is, do these ratios imply something fundamental that applies to the universe as a whole? This question is complicated by the fact that the numerator in the first two ratios is ill defined. After all, the universe is made up of all the structure we know and all we don't know. However, the first two of these three ratios seem

to imply that there may be a general relationship between the mass of structures found in the universe and their size as follows:

$$M \cong kR^2 \quad \text{eqn. (2)}$$

Where, k is constant. If this equation is to have any relevance it must apply to all masses in the universe. This, to good approximation, turns out to be the case (Figure 1 in Goodman, 1994) with k having a value of $\sim 0.5 \text{ kg m}^{-2}$. All structures found in the universe lie along or close to the $M \cong kR^2$ line.

Also relativity sets the maximum speed at c (speed of light) in the universe. This means that the maximum uncertainty in momentum any mass M can have is Mc . The momentum/position version of the uncertainty principle therefore implies there is a minimum mass that can be confined to any region of space (R) given by:

$$M \geq h/Rc \quad \text{eqn. (3)}$$

where h is Planck's constant. Taking eqns. (2) and (3) together (Goodman, (1994; 1997)) an infinite series of minimum masses can be calculated with each mass defining the next mass in the sequence given by:

$$M_n = M_\infty (M_0/M_\infty)^{(-0.5)^n} \quad \text{eqn. (4)}$$

where n has any integer value $0, \pm 1, \pm 2, \text{ etc.}$,

$$M_\infty = h/cR_\infty \text{ and } R_\infty = \sqrt[5]{h/kc}.$$

M_∞ has a finite mass of 1.4×10^{-28} kg as all parameters in R_∞ and M_∞ are constant. When one of the key masses found in the universe is inserted as M_0 in eqn. (4) (e.g. electron mass) all other masses in the mass series are defined. These all correspond, to good approximation, to the key masses actually found in nature over the entire range of our experience.

Not only does this mass series interlink all key masses in a very precise way it ties each of the first family of fundamental particles and associated forces to a key structure found in



nature (Figure 3 in Goodman, 1994). A recent portrayal of that figure is shown in Figure 2 below.

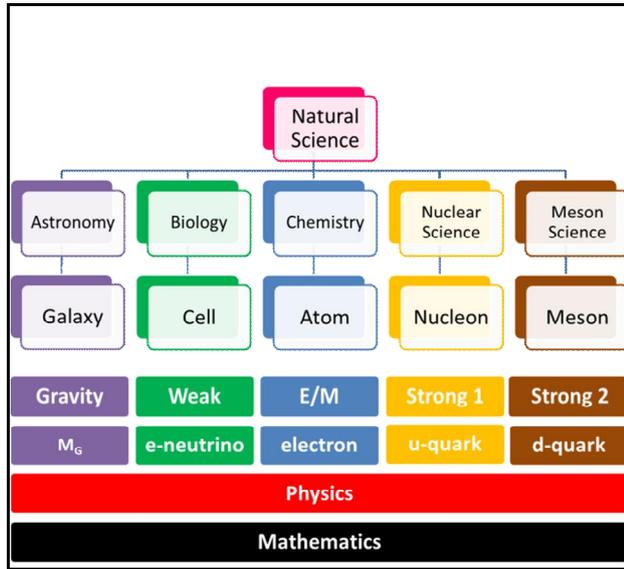


Figure 2. The mass series links structures, particles and forces in a very precise way (Colour version of the content from Figure 3 of Goodman, 1994).

Note that in this arrangement Physics is not considered a natural science as it is not the science of any particular *structure* found in nature. Instead it acts as an interface between mathematics and all the natural sciences. This allows us, for the first time, to begin to build a science of Biology and hopefully a science of consciousness eventually with a mathematical and physical underpinning.

4. Implications for life and a proposed model for consciousness

This mass series requires there to be a link between the electron neutrino mass, the weak force, and the biological cell and predicts the mass of the electron neutrino to be $\sim 0.16 \text{ eV}/c^2$ that is soon to be verified (Goodman, 2015). My intuition at the time told me this prediction could not be right. This was a result of my indoctrination during my undergraduate studies which had led me to believe that the weak force could not build any structure found in nature and could only be responsible for radioactive decay. However, over the last twenty-five years the arguments against such a link have weakened substantially and the arguments for such a link

have continually grown ever stronger (Goodman, 1994; 2015).

The second and third large number ratios, in eqn. (1) also suggest that the relative strength (S) of the force keeping a structure together is inversely proportional to the size (R) of the structure. As previously stated this relationship, to have any significance, must apply to all forces of nature in the universe and must apply over our entire range of experience from the largest of structures (galaxies) to the smallest of stable structures (nucleons) i.e.

$$S = \frac{\text{Constant}}{R} \quad \text{eqn. (5)}$$

The constant in eqn. (5) turns out to be R_∞ . This leads to a relative strength for the force associated with the biological cell of 10^{-9} which just so happens to be the relative strength of the weak force.

Furthermore, the general form of a force (F) operating in a three dimensional universe is given by:

$$F = S\hbar c/2\pi r^2 \quad \text{eqn. (6)}$$

where S is the relative strength of the force and \hbar and c have the usual meaning and r is the distance. The binding energy (E) is then given by:

$$E = \int F \cdot dr = -S\hbar c/2\pi r$$

Thus the decoherence time for the collapse of the wave function of a quantum superposition over a distance r is given by:

$$\hbar/2\pi E = -r/S c \quad \text{eqn. (7)}$$

This leads to a decoherence time for the weak force over cell distances (10^{-5} m.) of 10^{-4} s and over brain dimensions (10 cm plus) of 1 second. Those time scales correspond precisely to the relevant dynamical timescales of brain processes once again suggesting that the weak force and the electron neutrino are intimately associated with life processes and biology in general. In so doing

it also brings quantum effects up by six orders of magnitude from the atomic to the cellular and inter-cellular domain by virtue of the fact that the uncertainty in position of the electron neutrino, given that it's predicted mass is of the order of $0.16 \text{ eV}/c^2$, will be $\sim 10^{-5}$ meters. These quantum effects will also be at least six orders of magnitude more subtle than electromagnetic quantum effects in atoms and hence are likely to be very difficult to observe directly. This would explain why we have not noticed such quantum effects in biology before now.

The value of the work summarised in this and the previous section is, after a quarter of a century, finally being recognised as potentially important in the area of consciousness studies in Chapter 13 of a new book by Nunn (2016).

5. Toward a model for Consciousness

It has been proposed (Goodman, 2015) that nucleons will be able to swap spin over cellular and intercellular distances through weak interactions as follows:

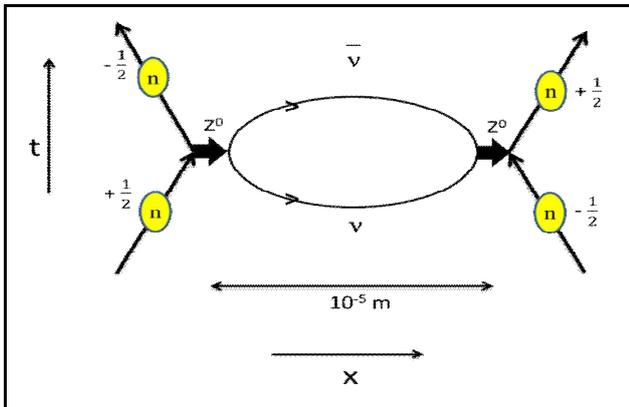


Figure 3. Possible mechanism for spin swapping, via a neutrino/antineutrino pair, between nucleons over cell and intercellular distances (Goodman, 2015).

What this Feynman diagram shows is that two nuclei could interact over cellular distances, without violation of the uncertainty principle, by virtue of the fact that the electron neutrino has such a small mass. This Z^0 interaction involving the emission of a neutrino antineutrino pair is already known to exist. Therefore, such a proposal seems reasonable.

Ignoring, for one moment, all the electromagnetic effects of neurological processes in the brain, the brain will consist of a 3d matrix

of approximately 10^{24} equally spaced ($\sim 10^{-10}$ m) nuclei. These could interact with each other over cellular distances via the weak interaction with spin up and down corresponding to the 0's and 1's of a normal computation and the nuclei themselves corresponding to the computers components that flip between 0 and 1. In this way the electron neutrino via the weak force may mediate the 'back action' of the conscious mind on the brain's neurology (Nunn, 2016). A brain could potentially process up to 10^{24} floating point operations per second. This is Yotta flop scale computing which is a hundred million times more powerful than the Tianhe 2 computer (the most powerful supercomputer in existence today). However, this analogy with computing must not be taken too far as brain processes and conscious thought are believed to be non-computable.

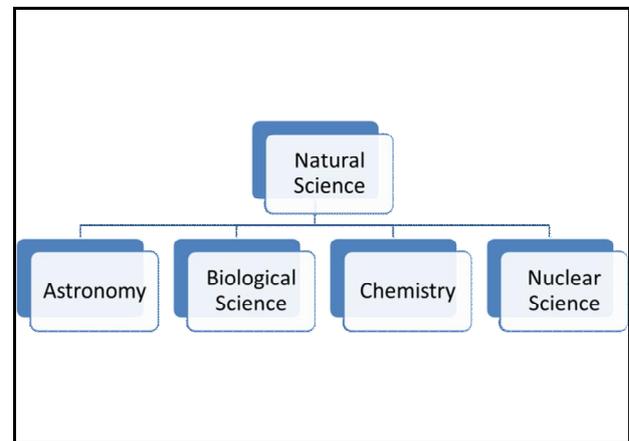


Figure 4. Arrangement of the Natural Sciences based on large number coincidences, relativity and the uncertainty principle.

6. Conclusion

It is quite shocking to think that, after 500 years, our current thinking on the natural sciences still suffers from pre Copernican intuitions. These discredited intuitions are causing us to arrange the natural sciences as we do today. This is preventing a physical and mathematical underpinning for all the life sciences and related sciences such as consciousness studies. A theory built, in the 1980's, from large number coincidences leads to a completely new arrangement of the natural sciences. The theory, to good approximation, predicts the key masses found in our universe. Each of the masses in the mass series has significance and the theory links all key structures, all known fundamental particles and all known forces of nature in a very



precise way. The theory also insists on a link between the weak force, the electron neutrino and material self-organization in general and the biological cell in particular which is an outstanding example of such self-organization. It also provides for the correct dynamical time and distance scale which correspond to those actually encountered in the brain. This theory also leads to the following new arrangement of the natural sciences.

The fundamental natural sciences are astronomy, biology, chemistry and nuclear science with the other life sciences and earth science being no more/less important than any other of the myriad of specialized branches (fields) of natural science. It is only when we can accept this, will we finally be free of our pre Copernican naive intuitions. This new

arrangement reinstates Biology as a physical science. But, there is no place for Physics as it is not the science of any particular structure found in nature. Physics acts as an interface between mathematics and all the natural sciences. In this way we have a mathematical and physical foundation for all the natural sciences. The new arrangement also suggests that if any science deserves the title of fundamental it is nuclear science as no structure (atoms, cells, galaxies etc.) would be possible in the universe without the existence of the nucleus inside the atom.

Finally, this theory allows us, for the first time, to begin to build a science of Biology and ultimately a theory of consciousness based on the weak force and electron neutrino that has a solid mathematical and physical foundation.

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