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Maurice Goodman
Technological University Dublin, maurice.goodman@tudublin.ie

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Article

Bias Impedes Progress in Physical Biology, Consciousness Studies & Quantum Gravity

Maurice Goodman*

School of Physics, Technological University Dublin, Ireland

Abstract

If scientists hope to make progress in consciousness studies they needs to accept that biased judgments have a major influence on the sciences, how we divide them up, how they are funded and this, in turn, has a profound impact on progress. The imbalance in funding, resulting from bias, in favour of the life and health sciences needs to be addressed as does why perversely little of this funding is devoted to a physics explanation of self-organisation and life on the mesoscopic scale? While life (the cell) is an outstanding example of self-organisation on the mesoscopic scale we need to be aware that self-organisation on this scale is ubiquitous in both animate and inanimate matter. The lack of effort, due to bias, to understand self-organisation on the mesoscopic scale is holding up progress in all biology related fields. We come face to face with our biases whenever theory predicts something unexpected such as the link between the biological cell, the electron neutrino, and the weak force. New results from KATRIN continue to support this link and has finally pushed the upper limit of the neutrino mass into the range predicted in the 1980's. Following on from this success nature also organises itself on the galactic scale. The implications for Astronomy are examined together with how our biases may be preventing an understanding of the role of quantum mechanics in nature. Extending the mass sequence, that predicted the neutrino mass, suggests a new mass associated with gravity and a way to resolve the, discrete versus continuous, conflict between quantum mechanics and relativity and incorporate dark matter and dark energy naturally into a more comprehensive model of the natural world where all sciences with associated structure are physical.

Keywords: Bias, impedance, progress, physical biology, consciousness study, quantum gravity.

Introduction

Twelve years has come and gone since this Journal was first published in January 2010. It was suggested, back then, that physicists were "avoiding the consciousness issue like a plague" (Hu and Wu 2010). Physicists are still not working in the consciousness area and I have long realised that there is something as fundamental as the electron which is needed to understand the atom, or the quark to understand nuclear behaviour, missing from our understanding when it comes to biology and consciousness. The lack of any fundamental physics principle upon which to base an understanding of biology and consciousness allows charlatans, with access to funding, to commandeer such fields promoting their preferred theory, however bizarre. Such theories only serve to clutter these fields of study resulting in a continued "mediocrity and stagnancy" that

*Correspondence: Maurice Goodman, Technological University Dublin, Ireland. maurice.goodman@tudublin.ie

hold up progress in areas such as consciousness studies. While all theories should be welcomed initially, there needs to be a minimum requirement that they are rooted in the mathematical and physics bedrock of science.

Our lack of progress also appears to have its roots in a whole host of biased judgements humans are inclined, and in some cases forced, to make. This paper attempts to highlight some of these biases, show how they impede progress, and suggest how less biased judgements, on our part, may aid progress in the physical sciences, in biology, and ultimately help lead to progress in consciousness studies, sometime in the future.

A physical biology

The dictionary definition of the word 'physical' is "of matter". The amount of matter is determined by the mass of a structure while the concentration of matter in a region of space is, broadly speaking, determined by its density. The following table shows typical values of these parameters for an iron nucleus, an iron atom in a block of iron, a typical biological cell and a galaxy. (A galaxy is approximated by a disk whose thickness is approximately one hundred of its diameter)

Science	**Structure**	**Mass (kg)**	**Diameter(m)**	**Volume(m^3)**	**Density(kg/m^3)**
Nuclear Sc.	Nucleus	10^{-25}	10^{-14}	$5x10^{-43}$	$2x10^{17}$
Chemistry	Iron atom	10^{-25}	$3x10^{-10}$	10^{-29}	10^{4}
Biology	Cell	10^{-11}	$3x10^{-5}$	$2x10^{-14}$	$5x10^{2}$
Astronomy	Galaxy	10^{41}	10^{21}	10^{61}	10^{-20}

Table 1. All structures found in nature are physical as are all the sciences of structure.

Table 1. Demonstrates that all listed structures are "of matter", have mass, and therefore must be physical. We consider Nuclear Science and Chemistry to be physical sciences, which is reasonable, as they contain relatively large quantities of matter. What is not reasonable is that we consider Astronomy to be a physical science even though its basic unit of structure (the galaxy) is 22 orders of magnitude (10^{22}) less dense than a cell whose science (Biology) is not considered to be physical. This is perverse and, as explained in a previous paper (Goodman 2018), demonstrates the unjustified autonomy assigned to biology. It also highlights our anthropocentric bias that is preventing progress towards a holistic biology that is integrated with the rest of the physical sciences. Our inability to explain how the cell becomes a cohesive whole does not make biology unphysical. Also, having structures with properties (e.g. mind and consciousness) that we cannot yet explain does not make biology less physical. Instead, the lack of explanation points to the incompleteness of physics which, I believe, will be rectified in the 21st century. Finally physics is not the science of any particular physical structure found in nature, and is therefore not a physical science. It is a science of the properties and interactions of fundamental particles, energy and bulk matter and as such acts as an interface between math and all the physical sciences.

Chemistry bias in biology

Efforts to explain biology as a complex series of chemical processes alone, have been shown to be inadequate. The failure of chemistry to explain loss of consciousness in the field of anaesthetics illustrates this point. A wide range of chemical substances from elements to complex molecules can act as general anaesthetics on all animals from, single cells to man. This makes no sense from a chemistry viewpoint and suggests that a very basic non-chemical cellular mechanism must be involved. One such element that acts as an anaesthetic, is Xenon. Xenon is a noble gas that has no chemistry, as its outer electron shell is full (chemically inert), and certainly not in conditions found in the brain. In biology the shape of molecules is often used to transfer information. However, Xenon is a perfect sphere of electron density which precludes transfer of information via molecule shape. Yet, as a general anaesthetic Xenon causes rapid changes in electron spin content in *Drosophila* (Turin et al. 2014). The nuclear spin of the Xenon nucleus also appears to have an impact on the potency of the isotope when used as an anaesthetic (Li et al. 2018). The common denominator here is spin and spin is not confined to nucleons, electrons or, for that matter, chemistry. Neutrinos also have spin. This raises the possibility that some biological effects (anaesthesia) may be unrelated to chemistry at all. Given what is known about Xenon's lack of chemistry and shape, it makes a lot more sense to consider non-chemical processes involving spin such as those previously proposed, in this journal (Goodman 2015), that suggest the existence of a non-chemical link between the electron neutrino and the global properties of the biological cell.

Chemical and Nuclear processes are not Quantum Biology

Quantum nuclear processes in the atom are, quite rightly, not referred to as quantum chemistry as the force involved is not electromagnetic and the particles involved are not electrons. So why do we insist on calling atomic and molecular processes such as photosynthesis in plants, photo transduction in the eye, enzymatic activity, olfaction in the nose, chemical energy conversion into motion, magneto reception, DNA mutation etc. quantum biology? A quantum biology workshop at a conference (TSC 2019) held in Interlaken, Switzerland in June 2019 is a case in point. All the workshop presenters related their contributions to nuclear, or atomic, or molecular structure and related nuclear or electromagnetic processes. Atomic and molecular processes are quantum chemistry not quantum biology. The work presented was quantum nuclear science or quantum chemistry not quantum biology, all be it in the biological domain. Quantum mechanics is by its very nature holistic and must refer to the entire system being considered be it nucleus, atom, cell, or galaxy. Quantum biology has yet to make its entrance and when it does it will treat the biological cell in its entirety as a holistic system. Convincing ourselves that we are engaged doing quantum biology, when we are not, is another example of human bias that is not helpful to progress in biology. Just as nuclear science does not explain chemistry, chemistry will not yield a complete explanation of biology as quantum biology will have little to do with the chemistry taking place inside the cell. In summary, quantum chemical and nuclear processes are not quantum biology.

Anthropocentric bias and funding

Anthropocentrism has plagued the mainstream scientific communities thinking (Goodman, 2017) for centuries, and still does so today. A previous paper (Goodman, 2018) discussed the link between anthropocentrism and the desire for autonomy in biology. By the late 18th century the support for anthropocentrism had become subtle as we continued to fool ourselves by separating life from all the other 'physical' sciences. The word Biology was introduced around the start of the 19th century and in a 40-year period in the mid-19th century it developed into a separate branch of science. From the outset it was argued that Biology was autonomous and separate from the other physical sciences and this is still the case in the 21st century. One of the 20th century's leading evolutionary biologists and philosopher of biology (Mayr, 2004) devoted an entire chapter to 'The autonomy of biology' in his book entitled: *What makes Biology unique?* It was first published as recently as 2004. He also suggested that Biology was the dominant science. This is just anthropocentrism in disguise.

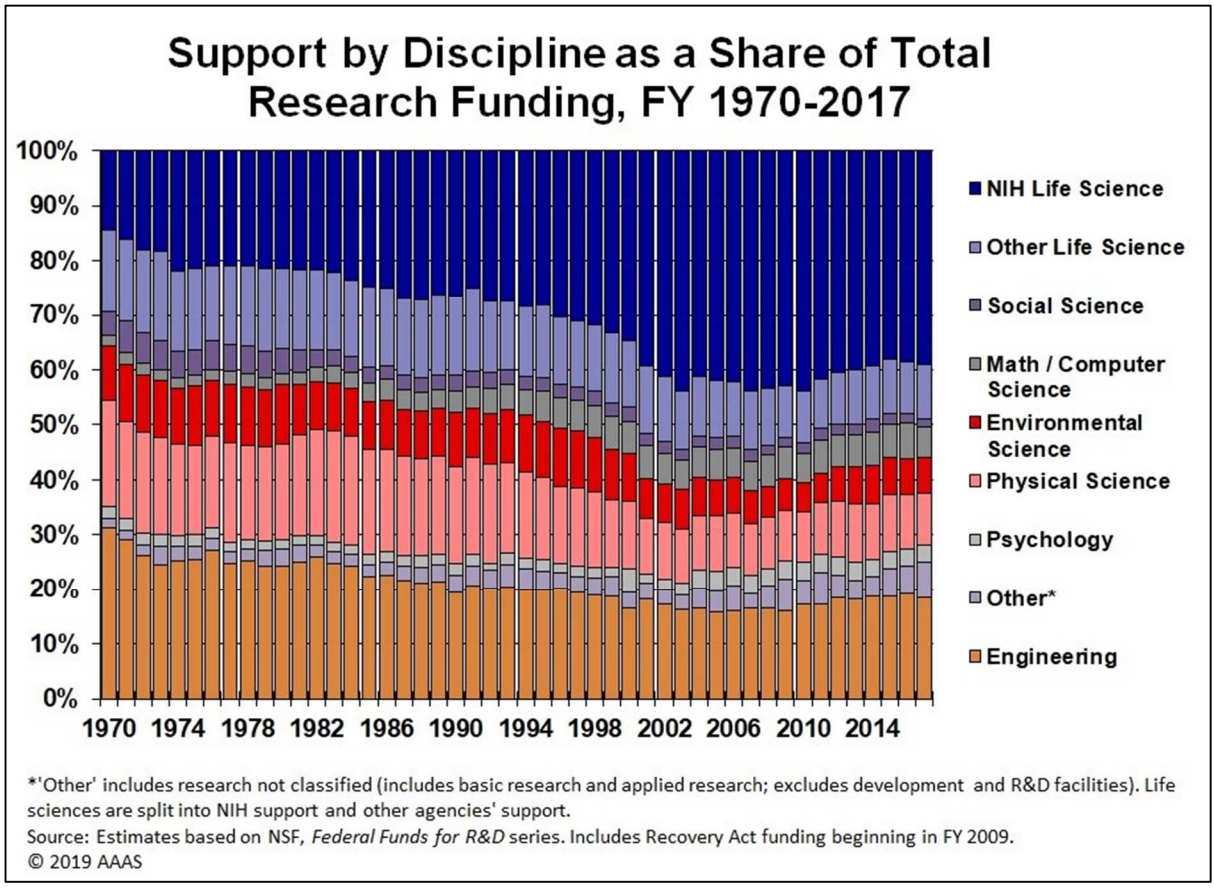


Figure 1. 90% of science research funding goes to life and related fields.

The dominance Mayr referred to (Goodman, 2018) was financial. A brief look at the funding, over the last half century (See Figure 1. for AAAS data), of scientific research reveals that, in the USA, more than 90% of funding went to life and life related science and engineering. For example, Computer Science is for the benefit of mankind as are engineering, social science, and

psychology etc. From 2001 to 2017 more than 40% of America's federal funds was spent specifically on human health with an additional 50% spent on related life sciences. This left less than 10% shared among the other 3 sciences. Also, of the few percent of funding physics received the majority of this was spent at the extremes of the very large (Astronomy) or the very small (fundamental particle) scale with little or none spent on the everyday scale of the physics of the biological cell or self-organisation in inanimate materials (Goodman, 2008). The missing physics, at this mesoscopic scale, that receives little attention or funding will be discussed in the next section. The current funding arrangements mean that most mainstream scientists work in the life sciences, or closely related fields, that have little interest in a math and physics underpinning for Biology. This gross funding bias has resulted in the other sciences (particularly Chemistry and Physics) becoming overshadowed and subordinate to the life sciences.

It is hard to escape the conclusion that a massive bias is at work here. Despite the huge spend in the many life science fields there is little funding to investigate the fundamental physics of biology. Once again, this bias is perverse. It is as if no one really wants to find a physics basis for life. In the words of the main character (Valery Legasov), in the recent HBO miniseries production, describing the events leading up to the disaster at Chernobyl in 1986: *"To be a scientist is to be naïve. We are so focused on our search for truth we fail to consider how few, actually want us to find it."* Such bias was also criticised by Sabine Hossenfelder in her book *Lost in Math* (Hossenfelder 2018). She says: "*We have failed to protect our ability to make unbiased judgements. We let ourselves be pushed into a corner, and now we are routinely forced to lie* (to obtain funding) *if we want to continue our work*". There is a clear conflict, in the present era, between honesty and the funding of science that we refuse to acknowledge. The biased allocation of funding is having a profound impact and is preventing significant progress in biology and the related field of consciousness studies. The bias and arrogance of mainstream anthropocentric scientists has also stretched as far as proposing that the current era of unparalleled damage on our own doorstep (planet earth), by humanity, be celebrated as the Anthropocene 'epoch'. A more appropriate word might be 'apocalypse'.

In summary, progress in biology and consciousness studies will not be possible until we face up to all of our subconscious biases and begin a focused effort to understand what is taking place, under our noses, on the mesoscopic scale.

Ubiquity and mystery of mesoscopic self-organisation

While the biological cell is an outstanding example of self-organisation on the mesoscopic (1-100 micrometres) scale, self-organisation occurs in inorganic matter on this scale also. There is a natural ability for material to self-organise on this scale, just the same as on the nuclear, atomic and galaxy scale. Toward the latter part of the 1990's research showed that a wide variety of non-equilibrium material processes led to structure on the 1 to 100 micrometre scales or greater (Goodman 1999). These structures occurred during phase changes from liquids to solids, in

liquid crystals, and during thermally driven processes or electro-hydrodynamic convection. They also occurred in chemical reactions such as the Belusov-Zhabotinskii reaction and intercellular calcium waves to name but a few examples.

Also, it was shown (Keber et al. 2014) that internally covering an inanimate vesicle, tens of micro metres across, with microtubule based active liquid crystals powered by molecular motors produced tuneable clocks and shape changing materials that resembled life like behaviour. The tuneable clocks produced oscillations of the order of 10^{-2} second's duration. This research demonstrated that topological constraints act much differently far from equilibrium. So life like were these effects it resulted in a focus on obtaining insights for basic biology. But the research group admitted that this goal was a long way off. More recently, self-organisation of skyrmions has been demonstrated (Hayley et al. 2019) in soft matter on the mesoscopic scale and communication between cells over distances of millimetres has been observed where chemical diffusion has been prevented using a solid barrier (Chaban et al. 2013). None of these mesoscopic effects can be explained using current theories in materials science.

Our unwillingness to face up to how little we want to understand what is occurring at the mesoscopic scale is exposed by the following two examples, one of which is for inanimate matter and the other animate. We have yet to figure out in skiing, for example, how exceptionally low friction coefficients occur or how a layer of hydrophobic material (wax) reduces friction further on the mesoscopic scale. The ice-water interface remains a complete mystery. (Canale et al. 2019). Worse still, in the life sciences we have tried to delude ourselves that capillary action and transpiration in leaves are responsible for transporting water tens of meters into a forest canopy. The maximum capillary action can achieve is less than 1 meter in height and the harvesting of maple syrup is done in the spring, when there are no leaves on the trees, and transpiration is therefore impossible. Also, osmosis can have no water transport role in the long continuous tubes up the tree trunk. Truth seekers attempting to explain life and consciousness need to understand not only the enormous ignorance of what is taking place at a fundamental physics level on the mesoscopic scale but, as stated earlier, that few people in the life sciences have any real desire to find out.

The parameters (e.g. density, velocity, temperature, concentration, etc.) used to describe these mesoscopic systems are assumed to be continuous (continuum hypothesis) even though matter is not continuous at a molecular level. This 'continuum hypothesis' assumes that inside a volume of ~ 10^{-18} m^3, (~1 micrometre (10^{-6} m.) in diameter), all the above parameters are constant irrespective of molecular behaviour and that local equilibrium prevails. This has no justification based on the properties and interactions of matter other than it appears to work which, once again, points to missing physics. This minimum length scale of 1 micrometre rather than atomic dimensions for all non-equilibrium pattern formation in fluids requires an explanation. In short, we need to identify what physics principle explains the success of the continuum hypothesis in so many different fluid systems on the mesoscopic scale. The correspondence of this scale to the cellular scale and the uncertainty in position of the electron neutrino suggest a common physics explanation for all of this and for fluids in general at that scale, which has yet to be discovered.

The current funding bias, highlighted in the previous section, does little to help, understanding of self-organisation on the mesoscopic scale, progress.

An unexpected link between the neutrino and biological cell

Our biases are firmly rooted in our ancient incorrect intuitions, formed during the long evolution of mankind, that when proved incorrect are only suppressed and resist being supplanted (Goodman 2016). A properly functioning observation-theory-prediction-experimental test cycle helps to pinpoint these subtle biases and accounts for all our scientific breakthroughs, in understanding our universe, since the dawn of humanity. In the 1980's such inductive reasoning lead to a prediction of all the key masses found in nature and showed how they were related to each other and to the forces of nature (Goodman 1994). However, the theory also predicted a link between the neutrino, the weak force, and the biological cell and predicted the electron neutrino mass. My initial reaction, in 1988, was that this could not be correct as it contradicted my intuitions and biases of which I was unaware at that time. However, each time I tried to prove that this link was not correct I came face to face with my biased and un-objective view of the world which in turn was based on the incorrect intuitions assimilated from the prevailing scientific culture of the time.

Over the last four decades the number of arguments for the link between the electron neutrino and the biological cell have continued to grow. In the 1990's these consisted of mathematical, symmetry, and handedness arguments (Goodman) (1994; 1997). More recently these arguments have related to quantum de-coherence times in the cell (Goodman 2015; 2016), 'global' quantum cellular communication, (Goodman 2016; 2018) and the fact that the mass that was first predicted for the electron neutrino in 1988 appears to be, at the very least, the right order of magnitude as discussed in the next section. Also, such a link suggested why processes in the mind and consciousness might be virtually but not completely weightless (Goodman 2017). This suggests how biology could be treated as a physical science integrating it with all the rest which in turn allows us to begin to construct a fundamental physics of biology and the cell. In the distant future it is hoped that such unbiased thinking may help fully explain mind and consciousness (Goodman 2018).

The evidence, for such a link, continues to mount up to the present day. Until now it was assumed that neutrinos would interact with single protons or neutrons in the nucleus. Recent evidence (Gran et al. 2019) suggests that neutrinos interact with pairs of nucleons inside the nucleus. So, for each neutrino trajectory at the interaction vertex there will be two nucleon trajectories. This lends support to the spin swapping mechanism between nucleons, over cellular distances, proposed a few years ago (Goodman 2015; 2016) as each of the two interaction vertices shown consist of just that, i.e. two nucleon trajectories at the neutrino interaction site.
Finally, the fact that tau, muon, and electron neutrinos can oscillate between quantum states indicates that their masses must be similar and within an order of magnitude of each other so as not to run into energy difficulties. This indicates that all three neutrino states should lie within, or close to, the mass predicted in 1988.

Reasons against a link, between the neutrino and biological cell, relate to our biases which are, as previously stated, rooted in our suppressed and ancient incorrect intuitions. The main reasons relate to our inability to detect an attractive aspect of the weak interaction, inability to detect interaction of neutrinos at low (milli electron volt) energies with bulk matter, our incomplete understanding of the weak force, and the notion that quantum mechanics is restricted to the minute nuclear and atomic scale only. These, in turn, are due to the lack of sensitivity of current experimental measurements today and as such they are not strong reasons. It is not logical to assume these interactions do not exist just because we are presently unable to measure them. An unbiased approach would allow for this possibility, until it is proved otherwise, and the weight of evidence over the last four decades is decidedly in the direction of such low energy neutrino/bulk matter interactions.

Experimental limits on the neutrino mass since 1980

By 1980 the upper limit on the neutrino mass was 65 eV/c^2 and the lower limit was 0 eV/c^2 (i.e. +1.8 to - ∞ on the log scale). This lower limit of 0 eV/c^2 remained valid until the beginning of the 21st century as shown in Figure 2 below. In 1988 an infinite mass series was derived which was eventually published in 1994 (Goodman 1994) and more recently in 2016 (Eqn. 4 reproduced in Goodman 2016). This work suggested that a mass labelled M_{-2} had to be associated with the electron neutrino mass. It was estimated that the exponent (2) in the relation $M = kR^2$, used to derive the infinite mass series, had an uncertainty of $\pm$ 5%. This meant that M_{-2} could be no more than 1 eV/c^2 and no less than 0.02 eV/c^2. If the exponent was exactly 2 then M_{-2} would be approximately 0.2 eV/c^2. In 1988 the initial mass (M_0), used to calculate all other masses in the series was taken to be the mass of the Universe (~ 10^{52} Kg). In 1992, M_0 was changed to be a typical mass of a galaxy. In 2007 it was realised that the only known fundamental particle mass that had been accurately measured was the electron, so M_0 was changed to the electron mass one last time. Hence the three different predictions for M_{-2} shown (in red) in Figure 2 over four decades, 1980 – 2020. All predictions of the neutrino mass used the same basic theory that was first developed in 1988.

In the last two decades of the 20th century the upper limit on the neutrino mass continued to drift downwards settling at 2.3 eV/c^2 (0.36 on the log scale) in the year 2000 with experiments at Mainz in Germany and Troitsk in Russia that made use of a new type of spectrometer called a MAC-E filter. The upper limit stayed at this value until 2019 when the first results from KATRIN, using the same MAC-E filter technology and measurement technique, were announced. The following year, in 2001, neutrino oscillations measurements between the 3 known eigenstates of neutrinos meant that the neutrino mass could not be zero and for the first time set a lower limit of 0.0001 eV/c^2 (-4 on the log scale) on the average of the 3 known eigenstates. Up until this point in time the prediction of the neutrino mass did not look particularly significant. Afterwards it began to look very promising. Improving measurements on neutrino oscillations continued to shift this lower limit upwards where it settled at its current value of 0.02 eV/c^2 (-1.7 on the log scale) in 2015. A summary of the status of the ongoing

laboratory work was given at the Neutrino Oscillation Workshop 2014 (Robertson 2015). All these changes in experimental upper and lower mass limits are shown in Figure 2.

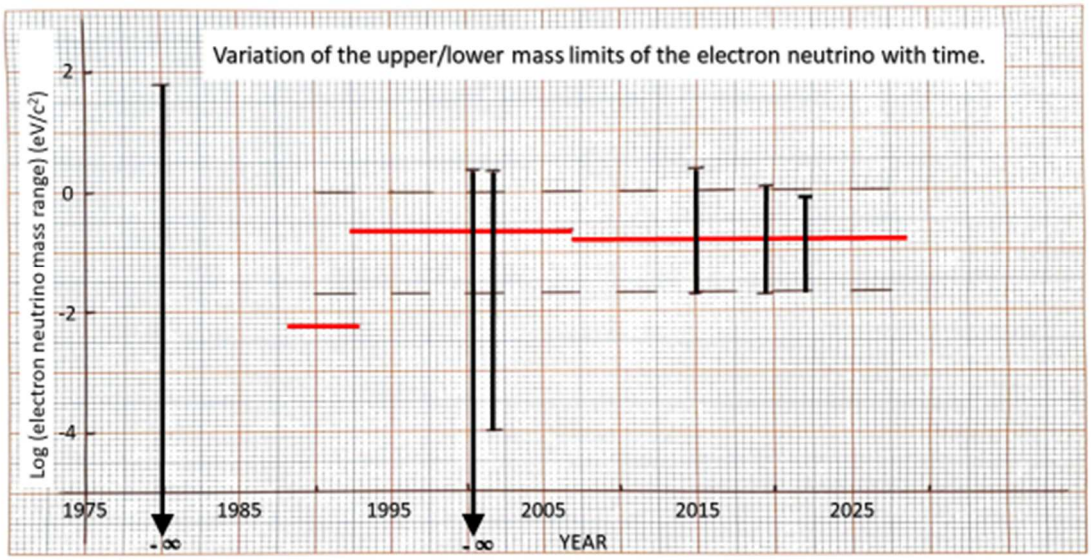


Figure 2. Theoretical prediction of electron neutrino mass since 1988 (in red) compared to experimental values over the last 40 years.

Recent results from the KATRIN experiment

In 2019 the first upper limit of 1.1 eV/c^2 (Aker et al. 2019) from the KATRIN experiment, based in Karlsruhe in Germany, was very close but not yet within the range indicated by the dashed lines shown in Figure 2. Neutrino masses within this range would make the neutrino a suitable candidate to provide a quantum mechanical channel for, an almost instantaneous, communication over cellular distances. The latest upper limit on the mass of the electron neutrino is now less than 0.8 eV/c^2 (Aker et al. 2022) and for the first time is within this range. Also, if KATRIN succeeds in measuring the neutrino mass it will also be in this predicted range. This, once again, increases confidence in the link between the neutrino and the biological cell first proposed 34 years ago.

In 2007 it was explained that wave like behaviour, and quantum coherence, could not occur between electrons over cellular scales (10^{-6}m) above a temperature of 0.01 Kelvin (Goodman 2007). Therefore, chemistry could not be responsible for any 'global' quantum processes in the cell or in the brain. This was because the mass of the electron is so 'big'. That paper also showed that quantum behaviour could occur for neutrino masses on that same scale at room temperature. In fact, using the current upper limit of 0.8 eV/c^2 this wave like behaviour and coherence could occur up to distances of a few microns at room temperature (300 Kelvin). The smaller the final mass of the neutrino, the larger the average distance between particles can be, pointing to the

possibility of coherent states over cellular and inter-cellular scales. This counters the 'Too wet, too warm, too noisy' argument that was used to deny the possibility of quantum mechanical effects and processes in the brain. If the mind made use of neutrinos instead of electrons such quantum states could easily exist.

As was done in 2003 (Goodman 2003) a rudimentary quantum cell could be modelled by postulating electron neutrinos in a square potential well, which is analogous to how we proceeded, in the early 20th century, when applying quantum mechanics to the atom. This model of the cell allows us to consider the corresponding wave functions in such cellular systems which depend on the prevailing boundary conditions. Following on from this, it is possible to calculate the quantum energy levels of such a cell sized potential well. Using a 0.8 eV/c^2 neutrino mass in a cell of size (L) of ~1 $x10^{-5}$ m, the lowest quantum energy level (E_1) for such a one dimensional system is given by $E_1 \sim h^2/8mL^2$ where h is Planck's constant, and m is the mass of the neutrino. This gives a value of a few milli electron volts for the lowest energy level. Therefore, the energy differences between energy levels, in such a square well potential, would be in the milli electron-volt range or smaller. In 1968 Frohlich (Frohlich 1968) proposed that there should be vibrational effects within cells that would resonate with microwave radiation from 10^{11} to 10^{12} Hz, resulting from quantum coherence phenomena. This radiation frequency corresponds to milli electron volts energies also (using $E = h\nu$, where ν is frequency). Is this a coincidence, or more evidence for a fundamental connection between the neutrino and the biological cell? It is clear from the energy level formula for E_1 above, that if the mass of the neutrino ends up being lower the size (L) of the potential well can be increased (within reason) to maintain the same values (milli electron volts) for the lowest energy level and between energy levels. Although this is a very crude model for a quantum cell it is reassuring that the calculated quantized energies appear to be of the right order of magnitude. Given that the mean thermal energy of any particle is 3/2 kT, where k is Boltzmann's constant and T is room temperature in Kelvin, the neutrinos would find it difficult to remain within the proposed potential well much above 100 ^{0}C due to their thermal energy, of ~ 50 milli electron volts, hence explaining why life would not be possible at much higher temperatures than found on earth.

Extending the mass sequence to include gravity

The 1994 paper (Goodman, 1994) successfully predicted, to reasonable approximation, the mass of 8 out of 10 of the key structures and fundamental particles found in nature. Now, with the addition of the electron neutrino mass, that has increased to 9 out of 10. Therefore, it is reasonable to speculate about M_{-4} (the mass series' other prediction). Using the electron mass as M_0, a mass (M_{-4}) between the mass of a cell (M_{-3}) and the mass of a galaxy (M_{-5}) with a mass value of 10^{-63} kg is predicted. This tiny mass will be referred to as m_g as it appears to be linked to gravity. This is not the massless, spin 2, graviton associated with the general theory of relativity. However, the predicted m_g value is in the same neighbourhood as current upper limits on the graviton mass from planetary motion considerations (Bernus et al. 2019). The uncertainty in position of this mass is of the order of the size of a galaxy or greater. A galaxy is another example of a complex system that needs a long range (over the entire galaxy)

information/communication system to prevent a decent into chaos. As per the arguments presented previously (Goodman, 1994; 2016), m_g would be to the galaxy, what the neutrino is to the cell, the electron is to the atom and the quark is to the nucleon. The 'quantum information' communication system of the galaxy could be provided through this predicted particle via the same quantum arguments presented in a previous paper (Goodman 2018) for the other three key structures of the universe (Figure 3.)

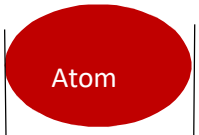
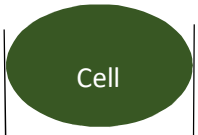
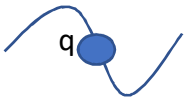
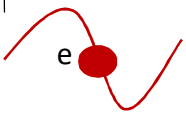
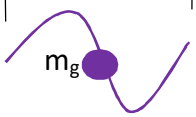
Fundamental Science	Nuclear Science	Chemistry	Biology	Astronomy
Force dominating	Strong	Electro-magnetic	Weak	Gravity
Self-organising System				
System Size and uncertainty in particle position	10^{-14}m.	10^{-11}m.	10^{-5}m.	10^{+21} m.
Key fundamental particle				
Communication via	quarks (q)	electrons (e)	e-neutrinos (ν)	gravity mass (m_g)

Figure 3. An extension of Figure 1. (Goodman 2018) to include Astronomy and gravity.

While the number of possible alternative arrangements of particles (a measure of the information therein) in a nucleon or atom that are allowed by the rules of quantum mechanics are relatively small the number for a galaxy would be truly astronomical and yet would be finite as a result of m_g's discrete quantum nature. This information/communication system would allow contact between all physical objects within a galaxy making all such objects interdependent and the galaxy a cohesive whole. The smallness of the energy quanta associated with m_g (of the order of 10^{-46} J) could provide an explanation for why the gravitational field appears continuous as suggested in relativity when in fact it is quantised. Also, it appears that it is the uncertainty in position of the associated particle that determines the effective force range responsible for building each structure in Figure 3.

Finally, there will be three distinct types of m_g in keeping with the three families of all other leptons and quarks. However, we are not likely to detect/measure these masses anytime soon as they are over 25 orders of magnitude smaller than the mass of the electron neutrino which we are getting close to, but are still struggling to measure after decades of effort.

A different approach to quantum gravity

Quantum mechanics and relativity have been incompatible since the foundation of both these fields, in the early years of the 20th century. Attempts to solve this dilemma have met with little success for the last hundred years. Previous, and possibly biased, approaches have always suggested we look at small length (Planck lengths of 10^{-33} cm.) and high mass (Planck mass of 10^{-8} kg) scales. We consider the presence of the three constants, h associated with quantum mechanics, c associated with relativity and G associated with gravity that make up the Planck mass ($m_p = (hc/2\pi G)^{0.5}$) as indicating we are exploring quantum gravity. This assumption may be biased and not correct. Here a completely different approach to quantum gravity is suggested that agrees with the conviction that quantum mechanics is a universal theory. The approach here is the exact opposite to what has been suggested till now i.e. long length scales (10^{+21} m.) and small mass (m_g) scales (10^{-63} kg.). This makes much more sense as it allows a role for quantum mechanics over the entire universe as the uncertainty in position of a particle obeying the rules of quantum mechanics is inversely proportional to the amount of matter in that particle. In the known quantum systems, i.e. the nucleon and the atom, the mass of the key particle associated with quantum behaviour decreases with increasingly more massive structures. I believe this may be where to begin to look for quantum gravity and a connection with relativity.

As stated previously the mass series is derived from the scaling law that the mass of all key structures and particles in the universe are roughly proportional to the square of their radius ($M \simeq kR^2$). This super linear scaling places limits on how large a complex structure can grow. In fact, if you look at the pattern in Table 2 you see that each force appears to have an attractive and a repulsive aspect.

Key Structure	**Force that Build (Attractive)**	**Force that limits (Repulsive)**
Nucleon, Nucleus	Strong	Electromagnetic
Atom	Electromagnetic	Weak
Cell	Weak	Gravity
Galaxy	Gravity	Dark Energy
Structure (10^{250} kg.)	Dark Energy	……?

Table 2. Force seem to have a building and a limiting role leading to the structures found in nature and suggests 'dark energy' as the next force in the sequence.

Each key structure found in nature appears to be built by one force and limited by the next in the sequence. The mass series may therefore supply an explanation for 'dark matter' that interacts through gravity. Despite over two dozen experiments since the early 1990's this 'dark matter' still hasn't been detected. A possible explanation is that dark matter is made up of light particles such as m_g that have too little mass to be measured. The mass associated with gravity (m_g) quite possibly will never be measured and certainly not in our lifetime. However, the increase in the number of fundamental particles with mass from three (u and d quarks and the electron) to five represents a 66% increase in fundamental particles that have mass and all that is required is for

them to be of sufficient abundance throughout the universe to account for dark matter. Dark matter would then be the contribution of all neutrinos, and all m_g's that contribute to gravitationally keeping a galaxy together.

Space stretching 'dark energy' which also slows the formation of galaxies appears, quite naturally, to be the next repulsive force (Table 2) in the infinite sequence. It limits the size of galaxies and fuels the Universe's accelerated expansion between galaxies as has been experimentally observed. Acceptance of this would require a replacement of the 'Big Bang' model of the universe with something new as the time needed for light to cross the next unknown structure in this infinite sequence (after galaxies), which has a mass of 10^{250} kg., (i.e. 10^{200} observable universes of matter) would be of the order of 10^{110} years (i.e. 10^{100} times the current estimate of the age of the universe).

Castles in the air

Table 2 also suggests the only role for gravity in biology is to limit how big a biological cell can get. This implies that space-time and quantum gravity have no role in consciousness nor is there a 'universal mind' (Grandpierre et al., 2013). Consciousness appeared on earth without significant influence from the rest of the universe and has to be firmly rooted in biology and physics theory. Also, quantum mechanics does not need a biased conscious observer for nature to progress. The rules of quantum mechanics were building atomic nuclei and the chemical elements in stars long before consciousness appeared on earth. Such 'castles in the air' that are not deeply rooted in the mathematical and physics bedrock of science should be discounted as they waste scarce resources.

Finally, the Standard Model of particle physics is already in a lot of trouble. It is not consistent with general relativity and cannot explain gravity. It does not account for dark energy and dark matter. It cannot explain the observed matter-antimatter asymmetry. It also suggested neutrinos had no mass. The proposed framework, linking all key particles, structures and forces, outlined in this and a dozen other publications since the 1980's, charts a path toward resolving some of these inconsistencies. This will also require the replacement of the 'Standard' model with some new and more comprehensive future theory that has a place for Biology (consciousness) and for Astronomy and gravity.

Conclusion

To begin to talk about consciousness we need our understanding of the basics of biology to be correct. We need to be careful not to let our biases cloud our scientific judgement, and so prevent progress. Quantum chemistry should not be confused with quantum biology. The truth about Biology is that it is a physical science that is not explainable by chemistry alone. We have subconsciously tried to deny this for centuries. My 40 year research career has been an attempt to

draw attention to this but, in my experience, very few are listening. To continue with the words of the character Valery Legasov: *"But it (the truth) is always there, whether we see it or not, whether we choose to or not. The truth doesn't care about our needs or our wants. It doesn't care about our governments, our ideologies, our religions. It will lie in wait, for all time, and this at last is the gift….."*

The total imbalance in funding and how it is allocated, as a result of bias, in the life and health sciences needs to be addressed. While life (the cell) is an outstanding example of self-organisation on the mesoscopic scale we need to be aware that self-organisation on this scale is ubiquitous in both animate and inanimate matter suggesting there is a whole host of discoveries to be made at this very accessible scale. A full explanation of what is taking place in biology and consciousness studies depends on progress in our understanding of physics at the mesoscopic scale.

Unexpected mathematical predictions such as the link between the neutrino and biological cell force us to face up to our biases. The latest evidence from KATRIN continues to support this link.

Nature also organises itself on the galactic scale and the proposed theory provides some interesting insights into quantum gravity and how it might relate to relativity and what dark matter and dark energy may be. Extending the mass sequence to include a new mass associated with gravity (m_g) suggests a way we might resolve the conflict between quantum mechanics and relativity by moving away from the idea that space is quantised on the minute Planck length scale. It also suggests an explanation for why no dark matter has been found despite 30 years of searching (too light to measure). Finally it suggests how to incorporate dark energy naturally into a new model of the particles, forces and structures of nature where all sciences of structure are physical.

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