Meaningful UV and IR photon-exchange within bio-tissue? — Interdisciplinary evidence, and a new way to view asbestos toxicity

Robert R. Traill

email: rrtraill4@dodo·com·au — *Tel.* +61-3-9598-9239
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ABSTRACT

This outlines eight little-known projects relevant to understanding non-chemical causes of asbestos diseases. Correlations with fibre-geometry suggest optical effects; hence this review considers *ultraviolet* and *infrared* projects:– *UV* for its likely direct effects on mitosis; and *IR* for its better documented bio-relevance.

(#**A**) "Ultra-weak" photon emissions of IR and UV from living tissue; (well-known in Russia since 1923, but largely ignored elsewhere).

(#**B**) A project initially seeking plausible mechanisms to explain the brain-and-intelligence theories of J.Piaget, and of W.R.Ashby (see Appendix-*A*). This indicated the need for additional "digital-string" mechanisms (plausibly ncRNA) to complement the acknowledged synaptic-system. Such molecular coding implied the need for IR intercommunication, and this led to identifying myelin as apparently having a second role as *coaxial optic fibre with appropriate geometry*.

(#C) Even ordinary (non-coaxial) transparent fibres seem capable of conducting *"crude zigzag"* light-signals.

(#D) Cope (1973) argued that standard mitochondria had the right dimensions to serve as resonance-chambers for the IR produced by ATP metabolism.

(#E) Many mitochondria are much thinner than "standard" size, lying along micro-tubules, and with cristae spaced in a way consistent with *UV*-related experiments. UV-production entails onerous extra energy-accumulation, possibly via ROS-like metabolism. But #G offers an extra surprising possibility:

(#F) Centriole as cell's "eye" which sees IR; (Albrecht-Buehler). Also microtubules as "cell-nerves" — consistent with #E, together implying natural UV signalling.

(#G) Goraczko (2000) demonstrated an unexplained health-benefit(!) from low-dose radioactivity. Such irradiation could offer free auxiliary photon-energy (by fluorescence) for UV metabolism.

(#H) Long-range insect-signals via IR fluorescence from pheromone molecules.

1. Introduction

Micro-biomechanisms are not always chemical; — *physics* can also play a role. Also note that asbestos and fibreglass both seem to be • unlikely as classical antigens, • largely inert chemically, and indeed • asbestos toxicity has been shown to be non-chemical.[1]

Meanwhile cooperation between the relevant scientific disciplines has been patchy. Sometimes this merely leads to "re-inventing the wheel" — but more often it simply entails *unnoticed* lost further-opportunities.

Thus this paper seeks to integrate eight physics-related projects which *collectively* tackle the problem: "What plausibly *triggers* fibre-generated carcinogenesis?" (a question then deferred to the second paper of this series). So first, here are the eight underlying projects and the interim generalisations which they lead to:

2. A surprising array of converging-evidence projects (#A–#H)

2.1 (#A) "ULTRAWEAK" BIO-EMISSIONS OF ULTRA-VIOLET AND INFRA-RED

The key new toxic-fibre explanation (arising later) will depend on the existence of some UV quanta within many living tissues — ultra-violet which seems to be playing some legitimate role.

There have been numerous reported observations of such "ultra-weak" radiation from all sorts of living material in reports dating back to the pioneering work of A.G.Gurwitsch in Russia in the 1920s[2,3] (then mostly written in German, see bibliography of 1931[4]). This was very faint radiation (*i.e.* with low photon-*counts*) which included both UV and IR, though this early work very much emphasised the UV, and explicitly saw it as **mi**togenic (hence the then-synonym of "M-rays").

Substantial evidence has since accumulated to support this effect, as further developed by such authors as F.A.Popp and others associated with the IIB (the International Institute of Biophysics, centred at Neuss). Thus for present purposes one *could* just accept such modern "#A" evidence and proceed from there. However within anglophone science there has been some continuing reluctance to treat this evidence seriously, or even notice it; so it seems prudent to at least outline the context further:

Certainly the findings must have seemed strangely like voodoo, particularly in the early days when: (i) Effects were just on the borderline of detectability. Moreover (ii) Taylor and Harvey (1931)[4] published a report of negative findings (which now raises the question of the *supposed-decisiveness* of one-lab tests when we are not quite sure what we are looking for, nor what complicating factors might be at play). (iii) The main support for the Gurwitsch findings were in Russia and Germany — countries which were either at war, or (at best) politically ambivalent bedfellows, for the whole period 1914-1989. (iv) Langmuir's influential public lecture[5] in 1953 unjustly treated these *"M-ray"* effects as being much the same as Blondlot's *"N-rays"* which *had been legitimately* discredited. (v) Connection with the Soviet regime would have raised Western suspicions of state-interference along Stalin/Lysenko lines — in some degree a "Kiss of Death".

Also some of it is quite difficult to read. This may be partly due to: (vi) The available English-language texts being *relatively-brief summaries* of earlier detailed expositions in Russian or German; and/or — (vii) The sometimes-odd use of words and phrases, which can be misleading.

Moreover (viii) these *apparently-mysterious phenomena* have been readily embraced by many "New Age" enthusiasts whose general spiritualistic outlook has very little in common with mainstream science: — another unwelcome Judas kiss!

SUMMARY OF SOME RELEVANT #A POINTS: — **(a)** Such photon emissions do exist as **apparently-rare** events. **(b)** They seem to relate to **mitotic** processes in some normally-constructive way, *e.g.* Goraczko (2000)[6] and Popp (2003)[7] — perhaps providing intercommunication or enabling-energy for synchonisation or other control. **(c)** Anyhow it must surely have at least one **legitimate role**, given its high quantum energy which must be difficult to achieve, *and* given its widespread occurrence in living matter.

We might also recall that: **(d)** UV photons carry significantly higher energy than IR, so they have more capacity to do direct **damage** if misapplied (as well as any damage due to disruption of timing or synchrony in any legitimate roles it might have). **(e)** Cancer consists of inappropriate mitosis and its consequences. **(f)** Because the skin is often exposed to sunlight, **UV is one major cause** of *skin*-cancer.

"But how do the internally-produced UV photons assemble the extra quantum-energy required, given that it will usually be about three-to-ten times the requirement for an IR quantum?" — See the discussion in "#G".

2.2 DIGRESSION: — A SPECTRAL CONTEXT FOR IR, UV ETC., AND THEIR WAVELENGTHS

Consider this list of electromagnetic radiations, and the wavelength-boundaries between them. Some of these boundaries are somewhat vague or arbitrary, but they will suffice here.

…… [≈100Km] *Radio* [≈5cm] *Microwave* [1mm=1000μm] *Far-IR* [≈10μm] *θNIR* [4μm] ***wNIR*** [1.5μm] ***vNIR*** [0.78μm=780nm] *Red* [610nm] *Orange* [590nm] *Yellow* [570nm] *Green* [500nm] *Blue* [450nm] *Violet* [400nm] ***UV***$_A$ [320nm] ***UV***$_B$ [280nm] ***UV***C(*normal*) [200nm] *UV*C(*vacuum*) [10nm=100Å] *Xrays* [overlap: ½Å=50pm, *to* 1pm] *Gamma rays* [20fm=0.02pm=0.0002Å] ……

Of course (as indicated in the list by the bold type), our main concern here will be with UV and NIR ("Near" infra-red). [V*isible wavelengths* are here either left for later consideration or treated as "honorary UV" with similar-but-milder properties].

The "A,B,C" subdivisions within UV, are standard and well-recognised: UV$_A$ is the relatively mild UV of supposedly-benign sun-tan and of "black-light" stage effects; while UVC is used as a deliberately-destructive disinfecting agent. "UVC(vacuum)" is so heavily absorbed by most matter that laboratory study of it tends to involve a *vacuum* environment (and/or fluoride salts for the milder cases)[8$_{p447}$].

Conversely, the "*θ,w,v*" subdivisions within NIR have been introduced here for convenience in the present discussion. E.g. "***v*NIR**" (*very*-Near IR) is generally less heavily absorbed by watery environments.[9$_{p57\text{-}Table}$] In contrast, the "***w*NIR**" band tends to be stopped by water within "*about* 20μm" distance — though, as one can see from the table, there is considerable fluctuation around that "20" figure, depending on the exact wavelength.

At body-temperature all objects are expected to spontaneously emit longer-wavelength *thermal* radiation (mostly >4μm)[9$_{Ch.14}$], so we can conveniently name this band as "***θ*NIR**" ("*θ*" for "thermal") — but such photons are too weak to be relevant here anyhow.

Of course the above figures refer to standard *"in vacuo"* wavelengths. Actual observed wavelengths will be shorter according to the relevant refractive index "*n*", thus: $\lambda_{medium} = \lambda_{vac}/n$. It may also help to recall how λ relates to frequency f, and c the *in-vacuo* velocity of light; thus: c [meters/sec] = λ_{vac}[meters/cycle] × f [cycles/sec=Hz].
Likewise: *velocity in that medium* = λ_{med}[meters/cycle] × f [cycles/sec] = c/n.
And of course — $c = 3.00 \times 10^8$ *meters/sec.* ——
Meanwhile $\lambda_{medium} \equiv \lambda_{med} \equiv \lambda$ (ad lib.); — and likewise: $\lambda_{vac} \equiv \lambda_0$.

Of particular relevance to what follows is that the ***energy per photon*** is directly proportional to the frequency (and hence to $1/\lambda_{vac}$). Thus *Quantum-energy* = $h\nu \equiv hf = hc/\lambda_{vac}$ — where h is Planck's constant, variously expressed as: 6.623×10^{-34} *joule/Hz* — or 4.136×10^{-15} *eV/Hz*. — [or somewhat confusingly as 6.623×10^{-34} *joule·sec*, — where the *"·sec"* should really be *"/(cycles/sec)"*, or at least *"·sec/cycle"*.]

2.3 (#B) THE BRAIN-THEORY PROJECT — WHERE IR-SIGNALS EMERGED AS A NEW KEY INGREDIENT!

This "brain" project has not yet involved itself with UV, but its conclusions about IR seem to offer some relevant analogies and generalisations, especially regarding overall corroboration between projects.

The original agenda for this "#B" project was — *To seek plausible brain-submechanisms which could explain Piaget's account of* ***psychology and intellectual development***;[10] — while at the same time, paying due attention to the tedious logistical constraints of real physics, information-technology, anatomy and physiology (especially at the ultra-micro level).

This analysis developed into two parallel "streams", of which STREAM 1 concentrated directly on *mind/brain/intelligence issues* and their wider biological implications, while STREAM 2 looked at the technical logistics likely to be entailed — and that is where *IR emissions* come into the picture. However it is helpful to set the context by looking at *Stream 1* first. Thus:

2.3.1 Stream 1 — Piagetian Psychology-and-Epistemology

This account ([11,10] etc.) seems somewhat remote from the present quantum-based discussion, so it is summarised in Appendix-*A* on page 12*ff*. It uses info-tech, physics, and epistemological reasoning to conclude that, (at least for *advanced* human thought-processes):—

• The recognised Synaptic/Action-potential system "[A]" is inadequate on its own, and must be supplemented by an "[R]" system providing *stringlike*-and-*digital* coding for *behaviour-elements* (partly inherited, but modifiable). • The most likely "string"-candidate was ncRNA. • *Such elements would mostly intercommunicate* ***via IR signals***; and • the "strings" were closely related to Piaget's *"schème"* concept.[11,12]

2.3.2 Stream 2 — Physiology and Embryology

Having once suspected there could be abundant meaningful IR signals within myelin and elsewhere, several likely corollaries presented themselves in succession:

(a) Myelin as optic fibre — indeed as the dielectric of a coaxial cable.

IR signals would probably need some means for travelling beyond mere neighbour-cell linkups — and (i) it just so happened that myelinated nerve-fibres seemed to have the right sort of optical and geometrical properties to act as ***coaxial optic fibres*** for the forecast NIR wave-

lengths; — (i.e. an *extra* role for axons — beyond their well-known pathway for action-potentials!). [13$_{p6}$]

This idea had later explanatory power, see below; but meanwhile:

(ii) There had been a prior paper by F.W.Cope (1973)[14] arguing the case for slightly-higher frequency infrared transmission within ordinary axons (even without invoking myelin!). — [Used in (b) below].

(iii) Cope had also postulated the storage of such infra-red as standing-waves within mitochondrial lipid membranes. — [The key point for Project #D, below, but less relevant here].

These latter suggestions, if valid, would appear to be useful confirmation for "(i)" because Cope had started from rather different premises (involving redox potentials and energy transduction).

(b) Optical interference-pattern as Myelin Template

Such *attempted* IR-traffic would probably pre-exist around axons *even before* myelin-growth (see "(ii)" above) — and more-so *during* myelin-growth. Then in addition to any axially-directed traffic, there would probably be *transverse standing-wave* interference patterns, and these could thus ***create a growth-template***. This template could then ensure that myelin stopped growing at "the right radius" (on reaching a "no-vibration" nodal surface, serving as a boundary or "moat" as illustrated elsewhere: [15$_{Ch7}$,10$_{p24}$] — and mathematically-modelled.[16])

This rather-rigid boundary would also explain the strange finding that the wrap-around layers of myelin tend to stop at about the same radial angle as their starting-point[17,18] — as if the growth-point could somehow smell-or-see that initial-start landmark through the rather impermiable layers of its own myelin. — *Or else, as now seems likely,* it could simply jam itself into the virtual cylindrical-template, until there is no room for yet another round. [10$_{p24}$,16]

(c) Other electromagnetic-governed templates might also apply elsewhere

The above template idea prompts the more speculative question: whether such IR-influences might control *other* anatomical geometry (etc.) within the *1μm–to–50μm* range of object-size. E.g. Recall (from the digression on page 3*ff*) that the effective reach of wNIR through a watery medium is limited to about *20μm*,[9$_{Table-11}$] so it might be significant that many cells are of this approximate size. (In contrast, *high lipid-content* cells can be much larger — consistent with the much longer IR-reach within fatty materials).

Moreover Albrecht-Buehler[19,20] showed in 1992 and 2005 that cells can align with each other *via IR communication through a glass barrier* — and that raises new theoretical possibilities. (He is also intimately associated with Project #F, see below).

(d) New Roles for Nodes-of-Ranvier — and maybe for Glia?

Each myelin "coaxial" is only as long as its segment between nodes of Ranvier (up to about *2mm*). At these gaps, the myelin-ends would necessarily act as "radio aerials" for any IR signals they might be carrying — thus broadcasting their message, perhaps in focussed beams, into the adjacent peri-nodal space. But where-to exactly? Other things being equal, the smaller the gap in relation to the IR wavelength, the easier it will be for the signal to just continue across the node and into the next "aerial" on the other side. However each node would also offer an opportunity for the signal to interact with other nearby structures (without any direct involvement

of far-distant synapses etc.) — and that suggests a possible ***new extra role for glia***. These supposedly-underutilised cells could thus also be a convenient locus for any of those *"schème-element, RNA-like"* molecules mentioned earlier, especially as there seems but little room to accommodate such molecules *en masse* within the neurons.

(e) Despite measurements, IR photons could be more abundant, and maybe UV also

It came to my attention in 1988[22] that F.A.Popp,[7] S.V.Konev,[23] B.Ruth,[24] and their school (Project #A) had already detected *many non-thermal cases of IR and UV emission*. In fact, this is probably "just the tip of the iceberg": Firstly, as Bókkon and others have pointed out, actual measurements take place several centimeters away, and that may well hinder effective measurement for any of the radiation frequencies. Secondly, given the drastic absorption-rate for IR in water, we might expect to detect only a small fraction of the actual IR emissions; (see the *"20μm"* comment within (c) above). Meanwhile however, such aqueous absorption would *not* normally apply to UV.

So, (e.g.) in cases where IR and UV *appear to be emitted equally*, one might argue that ***(at source) the IR would be much more abundant*** than the UV. That would be consistent with expectations that ATP-based metabolisms will usually deal in relatively low energy IR quanta; and that (in contrast) UV emissions would thus require special-and-rare procedures. Such rarity is postulated in general terms by vanWijk,[$25_{pp.192-193}$] concluding that: *"The probability of such an event would be extremely low but definite, fitting well to the extremely low luminescence yield…"* — and he says so in the context of a need for **E**-fields of the order of *1 to 100volt/μm*, which could be destructive if misapplied (see below).

On the other hand, it is possible that UV sources might also be more prolific, but that (compared to Cope's IR) their photons may be more purposively chanelled via microtubules so that fewer escape at the initial-wastage stage.

Let us now turn to a project which originates in electrical engineering rather than biology:

2.4 (#C) EVOLUTION OF THE FIBRE-OPTICS CONCEPT IN TELECOMMUNICATIONS

2.4.1 Basic cable-concepts — coaxial and "TEM"

In the 1880s, both Poynting[26] and Heaviside[27] upset the naïve water-flow model of electric-circuitry by showing that the actual energy-flow occurred *outside* the conductors, so any transmission-waves were going through the dielectric-insulator, and not the wire! — (a concept which later led to the invention of radio). For the coaxial cable case, that meant transmission *through the captive space* between the central wire and the outer metal sheath — with a cross-section like the white annular space in "⊙", where black = metal reflectors/conductors. Let us arbitrarily call such configurations **"case 1"**. (Here we chiefly consider the *"Main Wave"* or *"TEM wave*" which can exist using *any* wavelength provided that there are *two separate* conducting surfaces for the **E**-vectors to span between.)

2.4.2 Note on this "TEM mode" (or "Hauptwelle"[28]):

Here both the Electric and Magnetic (H) vectors are Transverse, so the energy flows axially: perpendicular to both **H** and **E** vectors — the situation which applies unambiguously when it is travelling unhindered through free space. But reflection can sometimes allow other secondary wave-modes, roughly equivalent to harmonics; see below.

2.4.3 Managing without those paired-conductors needed in traditional circuitry

Investigators had long been thwarted by the impossibility of actually detecting the theorised evanescent activity within metal conductors. Accordingly, in 1910, Hondros and Debye[29] explored theoretically the consequences of changing the metal wire *into a second dielectric* "region II" (but with a somewhat larger refractive index than its old annular companion "region I"). This disrupted the TEM waves, but allowed *secondary waves* to flourish within the newly constituted *dielectric wire*. We might call this situation **"case 2"**, with a format of "◎" while the (now remote) outer conducting-sheath has simply been forgotten, but there are *inter-linked* secondary waves within the two remaining adjacent media (I and II) — as illustrated by Schriever (1920).[28]

2.4.4 Note on these Secondary waves ("Nebenwellen"[28]):

(i) They can only survive by taking a **zigzag** course, with only one of the **E**-and-**H** vectors perpendicular to the axis.[30] Thus they are either "TM" (Transverse Magnetic) *or* "TE", but not both. **(ii)** Their half-wavelengths need to be short enough to fit within the relevant cross-section, otherwise they are "beyond cutoff" and die away.[30] **(iii)** Due to their zigzag path, their **axial** speed is reduced correspondingly, and **(iv)** different frequencies take different paths, so their axial speeds vary thus causing *dispersion* — usually detested within human telecommunications, though that need not always be true in biological systems, (e.g. see[$31_{\text{fig.C6.7/2a}}$]). There is also some place for such secondary waves in engineering systems when the goal is merely *to transport energy* rather than any neatly-timed signal. **(v)** Secondary waves *do not require* the paired-conductors needed by the old-style captive TEM wave (hence the changeover when the wire becomes dielectric).]

[A new variant wave-guide appeared in the 1930s due to Southworth[32] and others.[33] This time the metal re-appeared but in the annular *region I*, taking the form of a metal tube, typically using air as its inner dielectric (region II), with a cross-section format of "○". We may conveniently call this situation **"case 3**".]

2.4.5 Today's Fibre-Optics

The breakthrough for efficient fibre-optics was to allow the TEM-waves back, but without the embarrassment of energy-wasting metal wires or sheaths. Put crudely, the task was to trick the TEM waves into "thinking" they were in free space, by tactfully keeping them away from the outer fibre-boundary altogether! The most logical solution then was to organise a smoothly-changing gradient of refractive index, slowly diminishing as one progressed from the axis outwards — thus allowing any moderate deviation of the TEM to be steered back toward the central axis.

The format then would be, approximately: "  " or rather "  " — (viewed *side-on* this time, and with the darkness now depicting magnitude of refractive index instead of conductivity). Call this **"case 4a"**. (This possibly goes further than any example in nature — but it seems prudent to be aware so that we can recognise it if it does come to our attention).

Two more relevant variants of this (which are actually specialised reincarnations of the "◎" in case 2), use a mainly homogeneous dielectric fibre, but with a core which has a slightly higher refractive index, to achieve the same result. The overall fibre can be narrow enough to exclude zigzag waves: "  " (call it **"case 4b"**) — or it can be wider and hence more-inclusive "" (**"case 4c"**). Collectively, these *case 4* arrangements are a major factor in the current telecommunications boom.[34]

We can now return to biological projects, where some of the above cases might apply:

2.5 (#D) COPE'S TRAPPED-IR-PHOTON IN MITOCHONDRIA

As we saw in "#B:(a)(iii)" (p.4, above), Cope[14] had argued that there could be IR standing waves within mitochondria, because the *length and diameter* of normal mitochondria seemed compatible with IR wavelengths generated by their own ATP metabolism.

> "The diameter of the mitochondrion is of the order of 1 μ (nerve is 0.1–20 μ), which is of the order of one wavelength of infrared (IR). This suggests that nerve fibers and mitochondria might serve as resonant waveguides or resonant cavities for propagation of IR electromagnetic waves." Cope (1973,).[$14_{p.629}$]

As we shall see, this *mitochondrion idea* has important implications for "#E", where the idea is extrapolated to the UV case. Meanwhile he suggests a role for this IR capability: *"that the mitochondrion might act as a resonant cavity for IR electromagnetic waves, which could serve as a rapid and efficient method for dissemination of IR energy throughout the mitochondrion..."* thus facilitating feedback for its redox activity, etc.

2.6 (#E) NEW VIEWS ON MITOCHONDRIAL GEOMETRY — UV AND POSSIBLE SIGNALLING

2.6.1 Cristae as Centre-Discs rather than Side-Baffles

In their 2000 review, Frey and Manella[35] report numerous findings that the standard text-book account of mitochondrial morphology was inaccurate. Firstly *many (though not all)* mitochondria are very much narrower (also quite elongated and associated with micro-tubules).[36,37,38] And secondly, the previously accepted morphology of their internal cristae was misleading:— These had long been routinely depicted as *shelve*s or *"baffles"* (infolded from the inner membrane, at roughly-regular intervals down opposite *sides* of the sausage-shaped mitochondrion, and tending to interleave with each other across the enclosed matrix).

Instead it seems that the apparently-variable form of cristae is usually either *tubular* (about *28nm* in diameter), or else fused to form *"flattened lamellar compartments of various sizes"*. These cristae were still seen to be continuous with the inner membrane, but only via occasional stemlike *"pediculi"* — and hence tending to occupy central positions, *almost* detached from the sides, and reminiscent of a series of lenses-and-filters in a manmade optical-system (which might in fact be significant, as we shall see).

Citing Hackenbrock, they[35_{p322}] also report: *"considerable evidence that the mitochondrial inner membrane is a dynamic structure able to change shape rapidly in response to alterations in osmotic or metabolic conditions."* This could raise the question of what mechanisms might cause these *morphological* changes. (Note the comparable mystery of what limits myelin growth-control, and the possible cause via optical interference serving as a "template"; — §2.3.2(b), p.5 above).

2.6.2 Two Types of Mitochondria — "Oval" versus "Filaments"

The accepted view had long been that mitochondria were about *500–1000nm in diameter* (including Cope's claim of *1μm*).[14] However Thar-and-Kühl[36] summarise more recent evidence that *most* mitochondria are much narrower: "predominantly filamentous" with diameters being typically within the range (*300±200*)*nm*. They point out that the conventional text-book measurements relate to "isolated mitochondria", and thereby seem to imply that those measurements are less valid (though they themselves depict both types in their same diagram: *fig.1*). However this could also suggest that the two configurations *have different roles*, such as dispensing different quantum doses (and hence frequencies) for different purposes. In which case the mitochondria are perhaps adaptable, and able to reshape themselves to fit the task in

hand — (or indeed be shaped by that task, like the supposed control of myelin-thickness by the signal-traffic associated with it. — See #B: "(b)" again, on page 5.)

A division of labour?

Given that the thickness of optical fibres and cables tends to match the wavelengths carried, it is obviously plausible to postulate that the narrow mitochondria may be managing the production and distribution of UV, whereas the conventional oval ones could be dealing with IR as Cope suggested. Note that IR and UV would probably need to be handled differently anyhow, and that could be significant:

As mentioned previously, most **IR** is heavily absorbed in aqueous environments, so maybe that means that mitochondria have to more-or-less "hand-deliver their energy" to nearby where it is required. Or if the IR needs to travel *far* (with its energy or signal), it will plausibly then rely on lipid *myelin-links* as suggested in Project #B.

In contrast, **UV** would not have the same absorption problems, but (as we shall see in the following paper,[39]) its high-energy quanta would be *more dangerous to handle*. Meanwhile its smaller wavelengths should aid miniaturisation, which accords with the narrow mitochondria and the way they co-opt microtubules to collectively form a *nerve-like network within the cell* (as shown in T&K's *fig.1*,[36_{p262}] — and as suggested independently in Project #F, below).

Laser-like activity?

Cope[14] did not mention lasers nor "stimulated emission", though his model of IR reverberation does raise that hypothetical prospect. However lasing requires reasonably robust reflection at the two ends of the "echo-chamber", and mechanisms for that reflection were left rather tenuous in his account — enough perhaps to postpone quantum release, but probably not enough for routine laser activity. Moreover if IR is benignly "hand-delivered", such laser delivery would probably be superfluous and counterproductive anyhow.

In contrast, T&K[36] explicitly mention "laser" nineteen times regarding the *narrow-mitochondrion* case, and they go to some pains to postulate a plausible reflection-mechanism — not exactly at the ends of the "cavity" but by the collective effect of many weakly-reflective cristae spaced at appropriate half-wavelength intervals (allowing for refractive index). Note that this could only work well for a *long* "chamber" with many cristae, and that it has to be "tuned", at least to some extent. They barely mention UV explicitly, but the systems envisaged would (if valid) clearly be capable of producing lased quanta in the UV and visible ranges. (This assumes that the necessary supply of high quantum-energy is also satisfactory. See #G below.)

Such a system would probably be *unworkable for IR* with its longer wavelengths; so any extended chamber-length would doubtless be futile in such cases.

Meanwhile any such laser capabilities, combined with dedicated microtubule-pathways, could well facilitate accurate delivery of UV signals to "appropriate" destinations — with a minimum of danger to other cells or components, and perhaps a minimum of wastage (thus largely frustrating the would-be *observers* of such UV emissions!)

2.7 (#F) MICROTUBULES AS "CELL-NERVES"; — ALBRECHT-BUEHLER

I have already reported Albrecht-Buehler's demonstration[19] that cells could "see" each other's orientation through glass, using IR; — see page 5 within #B, item "(c)". — But I have very belatedly discovered that his overall investigations actually go much deeper, and deserve

special mention in their own right. (See his animated online account[21] *and* the journal references listed therein — [20] etc):

His project arose from a dissatisfaction with the tacit gaps in the official explanations about cell behaviour (just as Project #B arose from similar gaps in brain-cell theory). Certainly it had been long accepted that cells behaved in certain ways in given circumstances — but since the actual *mechanisms* underlying this behaviour were seemingly impossible to observe systematically, such enigmas seldom even entered discussion and were usually just taken-for-granted.

Albrecht-Buehler eventually made significant progress by applying *rigorous theory*. (Such rigour does become possible when the component building-items are small enough for us to envisage most structural possibilities, and hence express them in well-defined models or reconstructions. That applies to jigsaw puzzles and "reverse engineering" because the elements are artificially regular; but it also tends to apply with natural nanostructures which depend on a limited repertoire of molecular shapes and quantum-effects, etc.). Once he knew better what to look for, he was *then* able to demonstrate the plausibility of his conclusions via approved experimental approaches.

Anyhow those conclusions include viewing the typical animal-cell as having: • a 3D-seeing "eye" (the centriole, with its two perpendicular detectors appropriate for IR directional detection) — associated with • a sort of brain-centre (the centrosome) — which effectively has • a "nervous system" of microtubules radiating out from it.[21]

This picture is complementary to the one offered by Thar-and-Kühl [36] in Project #E (p.9 above); and their diagrams are similar. There seems to be no cross-reference between these two studies, and they focus on quite different aspects. — However *together* they offer a picture of a semi-autonomous entity which probably uses UV signals (sent within its own "nervous-system" at least, and probably also sent to any adjacent cells within range of its directional beams). Meanwhile any IR signals would probably follow quite different (lipid-centred) paths, and serve rather different roles (see Project #B).

In view of the corroboration, we would probably be wise to bear this model in mind henceforth, even if we do not yet feel fully convinced.

2.8 (#G) SURPRISING CLAIMS ABOUT "IONISING RADIATION" (GAMMA RAYS)

In 2000, Goraczko[6] published the remarkable well-documented claim that *small doses* of ionising radiation were actually *beneficial* to health! Taken on its own, this seems to make no sense (except as exemplifying the rather mystical "*Arndt-Schultz rule, that 'small stresses stimulate'* "). However in the present context, one can envisage a plausible mechanism and rationale:

My main past misgiving about Project #A was scepticism that normal metabolism could readily assemble enough quantum energy to produce UV photons in sufficient quantity. But evidently such ambitious "anti-Stokes" energy-buildup *is* possible (and presumably involved with the narrow mitochondria of Project #E).

[We may recall that in the 1800s, G.G.Stokes noted that *shorter*-wavelength light (which we now know to have photons of higher energy) could *readily* lead to fluorescent re-emissions of *longer*-wavelength-light — but not the reverse. In fact though, the reverse *is* possible, but the extra energy has to be added somehow — e.g. by metabolic stage-related accumulation processes.]

Meanwhile however, the occasional incursion of those super-energetic gamma-ray photons would certainly offer an easy alternative — a straightforward Stokes-type energy source for generating UV quanta. In small doses then, this could well facilitate whatever it is that the supposed "UV-system" happens to be doing; — see "Postulate 1" below. Of course the radioactive or cosmic rays would also entail risk, but at low doses the trade-off might well be worthwhile — especially if DNA redundancy usually enables full repair at those low doses.

Incidentally Goraczko's abbreviation for ***i**onising **r**adiation* is "IR" which is hardly helpful here! I therefore suggest *"IoRad"* instead.

2.9 (#H) LONG-RANGE IR "CALLSIGNS" FROM PHEROMONE FLUORESCENCE

How do some insects detect mates over long distances? E.R.Laithwaite[40] and P.S.Callahan[41,42,43,44] each partly explained this mystery. For both authors the explanation depended on IR, but there were some unresolved details in the 1970s — not helped by some misleading assumptions. Also Callahan and his main critic *both confused the long-range* issues with the *logically-different case of short-range* detection where one can obviously invoke orthodox olfaction instead (as Laithwaite had previously explained!). This confusion needlessly delayed progress for decades.

However a recent review[45,46] of the published accounts gives a clearer indication of the scenario: It seems that ambient radiation (even at night) probably causes Stokes-type species-specific IR-fluorescence when it interacts with air-born pheromone molecules. The insects would "see" this re-radiation — though not with their eyes, nor even probably with their antennae(!), but rather by using the arrays of "hairs" on their bodies as collective aerials (like radio-astronomy aerial-arrays writ small).

3. Summary and Conclusion

What can we deduce from this curious ensemble of evidence? Firstly:—

3.1 Note the mutual agreement between unrelated works

This corroboration offers what knowledge-specialists like Piaget might identify as "equilibration" — the forming of an apparently *coherent* overall model[11,47,48]. Of course that does not prove anything with absolute rigour, (indeed nothing ever does, as Wittgenstein and Gödel told us years ago!). But in practical terms we can probably agree that there are *good grounds for at least taking this new collective view seriously*, and that should imply a readiness for further experimental testing (where possible) of any of the issues which seem questionable.

Moreover, if this new collective view is at all on the right track, that could help us considerably in *designing new experiments*. (After all, it is particularly difficult to make experimental sense of a complex phenomenon if one has misleading notions as to what the most significant variables might be).

But what does this new ensemble tell us anyhow? It amounts to a strong radical suggestion, which is best expressed here as a hypothesis:

3.2 Postulate 1: That, in addition to the well-known chemical metabolic system, there also exist IR and UV metabolic systems (regardless of whether or not we yet understand their roles).

Project #B had proposed the existence of an IR/RNA communication-mode "[R]" (supplementary to the acknowledged action-potential system, "[A]") to explain human intelligence in terms of real biological "hardware", based on Piaget's *abstract* concepts, and interpretable as micro-Darwinian strategies.[11]

Projects #A, #E and #G have collectively given some picture of the supposed **UV** system, (for which the name "[U]" now seems appropriate, even if it is still somewhat hypothetical). And it seems that this [U]-system has close connections with mitosis and its control; though it is not yet clear what "the grand plan" of this apparently-important system might be. Despite that uncertainty, this UV system now leads us to:

3.3 Postulate 2: That narrow optic fibres are toxic because they disorganise the supposed UV metabolic-system.

That will be the topic for the following *"paper 2" on this asbestos theme*.[39]

3.4 But then — Should such ideas surprise us?

Today we make prodigious use of **IR** signalling, so would it be too radical to suppose that nature may have long ago discovered the benefits of such methods?

Meanwhile the possible role for **UV** is a bit more surprising at first — given that it requires about three-to-ten times as much energy per photon. But consider the practical logistics of size (in space-*or*-time), and how one tends to match wavelengths to the size of the significant "objects" of that domain. — (Thus the Action-potential system [A] is fine for muscle-control and many other comparatively-macro tasks like signal-*steering*, but it was rejected within Project #B as *totally-unsuitable-on-it-own*, for the routine code-processing at subcell level required for *advanced intelligence*. So that led to the postulate of an [R]-system using IR.)

Now if we step down to a *yet smaller* domain, where the focus is on some still-mysterious DNA/mitosis manipulation, then we might expect a need for yet shorter wavelengths, despite the inconvenience of higher quantum energies. That, in part, seems to account plausibly for the mysterious presence of UV emissions much discussed within Project #A.

Or we could put the matter somewhat differently, taking our cue from the dual nature of mitochondria highlighted by Project #E. The recently-identified *narrow* mitochondria seem to have optical reflection-properties which could only work with UV. In contrast, the familiar "oval" mitochondria evidently deal with *IR* (for which the UV-reflection strategy has no hope of working because, amongst other things, the cavity-length would need to be some three-to-ten times greater than for the narrow "UV" mitochondria). However other more-orthodox energy-delivery strategies do seem to be open to these traditional "oval" mitochondria.

4. APPENDIX A

SUMMARY OF THE PSYCHO-EPISTEMOLOGICAL ORIGIN OF "PROJECT #B"

This "Stream 1" theme led up toward the eventual conclusion (in "Stream 2") that infrared signalling is likely to be playing an important role within the nervous system (and not just in manmade gadgetry!). But let us look at the logical background to that study:

4.1 Stream 1 — Piagetian Psychology-and-Epistemology

How is human knowledge even possible? — Can we suggest, at least in principle, any *biologically-realistic* detailed process for the encryption, structure, and retrieval of knowledge? — Such questions are basic to *Epistemology*, the study of knowledge-acquisition in general (which seeks to explain the four separate learning-abilities of: mind/brain, society, immune-system, and DNA).

The psychologist/biologist and self-proclaimed epistemologist, Jean Piaget (1896-1980), offered a partial solution by invoking an abstract mental element called a "schème" within the mind/brain. Each basic schème embodied some component of ***action*** (akin to a ***verb***), which might then be built up with others to form compound schèmes (including *noun*-like concepts such as "this toy"); e.g. by a link-up of the basic schèmes used whilst manipulating that toy during play (and suppressing the original overt actions, now simply internalized).[47]

Subsequent work[11,10] set out to find ***physical embodiments*** for Piaget's abstract schème, bearing in mind its apparent properties (which lead in turn to newfound specific communication needs which involve IR, as we shall see):

4.2 ESSENTIALS OF THE PIAGETIAN SYSTEM

(These "essentials" are rarely made explicit by Piaget himself! — perhaps because "theory" was often a dirty-word within non-mathematical sciences during most of his life.[11_{p33}]:

(1). His revolutionary emphasis on ***action*** (*not object*) as being fundamental. In retrospect one can see this as analogous to Darwin's revolutionary emphasis on spontaneous *genetic change* (rather than any fixed eternal speciation)..[$11_{Table"S"}$]

(2). Actions emerge as time-related signal patterns, but meanwhile they must presumably be *encrypted in some sort of* ***physical store***. (Piaget merely implies this[12,11].)

(3). The notion of a "repeatable action" implies discrete ***digital storage*** of some sort, with definite "switch" or "alphabet" settings, rather than the analogue settings implicit in synapse-placings etc. (That is not to deny the usefulness of analogue mechanisms, nor to belittle synapses; but it does suggest the need for a division of labour between digital and analogue).

(4). Actions are principally organized as *one-dimensional sequences* (***1D***), even if these are then strung together (perhaps in virtual "iPhone-linked" space) to form sketch-like 2D or 3D concepts.

(5). We can see the invoking of such schèmes as being *initially disorganized and random* (either initially-within-the-individual, or initially-within-the-inherited-DNA of the species); — pending ***selection*** *and organization* through experience in the real world.

(6). After an initial "sensori-motor" period, the infant has acquired nounlike concept-schémata. It is then possible to apply new "Meta-Level" schèmes which ***act internally*** upon those "nouns" (instead of causing actions aimed at the environment). This offers a first step in the development of *introspection and abstract thought*.

(7). Such "basic abstractions" can then be abstracted further, in successive stages of development.[9,11,47,31]

4.3 COMMENTS ON THE PIAGETIAN SYSTEM

Firstly we should note that this Piagetian system gives an in-principle explanation of the working-and-development of the human mind, which seems to account for it much more closely than any other available theory. Moreover it exhibits a strategy of *coherence-seeking* (both within the scientist[48,45] *and* within the person-or-system being studied).

Secondly it is notoriously difficult to investigate the detailed holistic-and-micro workings of the mind/brain. Direct observation is virtually impossible on any useful scale. That seems to leave us using the best available theories as benchmark in interdisciplinary research-activity.

As it happens, the question of identifying the material basis for the "schème" is just such a *difficulty*. It creates an *anomaly* if one insists on clinging to text-book neurophysiology (which lacks credible building-mechanisms). And in suggesting solutions to *these* problems it does also

offer *unforeseen solutions* to long-standing mysteries elsewhere; see "Stream 2" (p.4, within §2.3).

4.4 BEYOND PIAGET — SEARCH FOR A MATERIAL BASIS FOR THE MIND/BRAIN

Evidently the typical basic schème-component must consist of: *a physical 1D-string of digital-codes* — just to satisfy "(2,3,4)" above, (i.e. Physical, Digital, and 1D, respectively).[11,47] So then, what biologically feasible stringlike candidates are there? There seem to be five contenders, of which most are much smaller physically than previously envisaged: thus •DNA/histone, •RNA, •PNA, •protein, — as well as the more orthodox: •"Some 1D string of neurons".

In fact it seems that *those "orthodox neurons" can be quickly eliminated* from this schème-role because: ♦ there seems to be no evidence that any neurons ever form into such restrictive sequences. ♦ Such use would seem grossly inefficient anyhow. ♦ Their usual proliferation of dendrites would be quite counterproductive. ♦ They are not digital enough (though that was not realized mid-century when much of the early theorizing occurred).[49,50] Also ♦ synaptic changes are *not fast enough* to account for real-life adaptations, (*e.g.* in sport and other feats of rapid short-term memory).

4.5 MACRO-MOLECULES AND IR

That leaves us with the macro-molecules. For our present purposes we need not decide which sort (although the present evidence strongly favours RNA [11] and/or some epigenetic histone-switching for DNA-control). Provisionally, it will often suffice just to speak of these as *"RNA-like"* components of the inferred molecule-based "**[R]**" system — operating in symbiosis with traditional neurons within their action-potential "**[A]**" system.

The difficulty of most interest here is that any digital finesse of such molecules could not be efficiently and precisely rendered into to the language of *action-potential spikes of orthodox neuronal communication.* — At least such translation would be irksome on a *routine* basis, though clearly there must be some communication between the two systems, [A] and [R].

In fact **short-range infra-red** would be the most likely alternative signal-link between RNA-like molecules, given that the normally expected quantum jumps during routine metabolism are about *0.5–1.3 eV/molecule* [51] (i.e. *48.2–125.4 KJ/mole*), amounting to quantum wavelengths of about *2.5μm–1.0μm* respectively. These figures both indicate infra-red (IR) — indeed they are both "*Near* infra-red" (NIR) — see the list of wavelengths in §2.2 (page 3).

Given the above discussion about supposedly-normal quantum jumps yielding infra-red (IR), it then seems anomalous to find that the observed "ultraweak" wavelengths of Project (#A) included ultra-violet (UV) as well as IR. This comes as a surprise because it is not obvious how the metabolic processes manage to collect-together enough extra energy to emit a UV quantum with at least twice the "normal" frequency. But then, that is the much-replicated finding of Project (#A), so the energy must have been assembled somehow, and that fact (though only loosely explained) does add an interesting twist to the cancer-causation discussion.[39] Meanwhile the fact that all sorts of quanta in the NIR-UV range are likely to be available, does make the molecular schème-element suggestion seem both feasible and instructive. Moreover there is more circumstantial evidence within "Stream 2", to which we might now wish to return — (page 4).

5. APPENDIX B

"LEGITIMATE HYPOTHESIS" VERSUS "WILD SPECULATION"?

"…probably he who never made a mistake never made a discovery."
— Samuel Smiles, *Self-Help*, Ch.11. (1859)

"The man who makes no mistakes does not usually make anything" — E.J.Phelps, (1899).

5.1 Even the most respected views can eventually turn out wrong or inaccurate

In science, fallibility goes with the territory whether we like it or not. The practical problem lies in divining how profitable it is likely to be to take 'Theory X' seriously — though we *could* consider all-comers on a trial-and-error basis, at least provisionally. Either way it behoves us to maximize our understanding of this process of how knowledge is actually built up.

Trial-and-error is often disparaged, but let us not forget that it is at the heart of Darwinian Evolution — a very robust strategy, even if we think we can do better by adding *intelligence*.[1] But that same *intelligence* can be severely burdened whenever decisive clues are missing (or have simply been overlooked so far). Certainly it sometimes helps to do more lab-work in the hope of gleaning those missing clues. But even then one still has to fit such new-or-old clues together using some modicum of *judgement*, and that actually means making a *logical leap* — a step which is not justified by strict logic, but which offers a more "coherent" account of the currently-acceptable "facts".

Alas, such coherence-seeking postulates can sometimes lead us astray; but then, what else can we do when we have wandered into uncharted territory? The real art of knowledge-building is to recognize that all our postulates are ultimately on shaky ground, so they need to be kept under recurrent review — especially in the light of new evidence — or on sober re-evaluation of new ideas after accepting them provisionally on a "what if" basis. Here we should also consider Popper's views — *and* the corrupted versions thereof which have passed into popular cliché.

5.2 Popper's own views — versus the popular "Popperian" view

In Popper's own words[52 pp32-33], but with added "{..}"-placemarks and underlining:

"According to the view that will be put forward here, the method … always proceeds on the following lines. From {1} a new idea, put up tentatively, and not yet justified in any way — an anticipation, a hypothesis, a theoretical system, or what you will — conclusions are drawn by means of logical deduction. These conclusions are then {2} compared with one another and with other relevant statements, so as to find what logical relations (such as equivalence, derivability, compatibility, or incompatibility) exist between them.

We may if we like distinguish four different lines along which the testing of a theory could be carried out. First there is the logical comparison of the conclusions among themselves, by which {3} the internal consistency of the system is tested. Secondly, there is the investigation of {4} the logical form of the

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[1] One part of the Ashby/Piaget Brain-Theory account tells us that this ***intelligence*** apparently arises due to a hierarchical organization within the mind/brain, whereby the "boss meta-level" (M^1L) learns how to *direct* the lower-level activities (M^0L) so that they become more efficient, less random; — but then a higher boss (M^2L) learns how to organize (M^1L) … — and so on. This appears to allow us abstract-and-logical thought which we like to consider "perfectable" — and yet the top "M^nL" (whatever "*n*" may be) will still have to fall back on *simple unguided trial-and-error*, with its inevitable (vestigial?) fallibility. [10,11,15,31]

(Here we have been considering the mind/brain of *the individual*; but the same principle arguably applies to "Social Intelligence" in the form of "Science" as a recognized arm of *"Society-as-Such"*, with its own collective pseudo-intelligence. [11 espec.Table "S"])

theory, with the object of determining whether it has the character of an empirical or scientific theory, or whether it is, for example, tautological. Thirdly, there is the {5}comparison with other theories, chiefly with the aim of determining whether the theory would constitute a scientific advance should it survive our various tests. {6: See below} And finally, {7} there is the testing of the theory by way of empirical applications of the conclusions which can be derived from it.

The purpose of this last kind of test is to find out how far the new consequences of the theory — whatever may be new in what it asserts — stand up to the demands of practice, whether raised by purely scientific experiments, or by practical technological applications."

Comments: Firstly, this looks very like the apparently-independent accounts of Piaget[11], and of Paul Thagard [47,45]; and somewhat like the ideas of William Whewell (1840/1848). In particular: {1} The "**new idea**" ≈ Piaget's "schème" — while {2,3,5} "**consistency**" ≈ Piaget's "*equilibration*", and Thagard's "*coherence*" (also known to other modern philosophers), plus Whewell's "*consilience*". Moreover Piaget also speaks of how such innovations can be remoulded to fit in with existing concepts, in a process of *"assimilation"*.

{6} What Popper does not mention is the possibility that the pre-existing body of knowledge might somehow become adjusted to see if the new ideas might fit in; — a process which Piaget reasonably calls "*accommodation*".

[The real "heresy" of the present paper is that it challenges the *unnoticed assumption* "that we already know all the basic metabolic-substrates (even if we don't quite know how they all work)." Discovering the action-potential mechanism of nerve-fibre was indeed an immense accomplishment; and psychologically one can appreciate the assumption that this was the complete system — although *logically there could still be other* less-obvious mechanisms doing similar things *at the same time*. However it would not be too much of an "accommodation" to re-adjust to a *pluralistic view* if that now seems warranted. Likewise for the idea that UV might be doing some of the tasks previously attributed to cytokine-chemicals].

{7} Certainly any theory (new *or* old) should be tested for its practical applications (and re-thought, modified/assimilated, shelved, or rejected if it consistently fails that test). Such tests will tend to be with *physical* systems; (and the immediately-following paper[39] offers scope for just such testing for the main postulates of this present paper). However "testing" can surely sometimes come mainly from any *theoretical clarification* which it bestows (which *may then* lead to physical consequences, but that's another matter). That, I believe, is the main role for the present paper; and that freedom to measure validity via *internal coherence* (as well as the "*external coherence*" of experimentation) seems in accordance with Thagard's view, at least.[48]

Most people assume that "testing" means "physical testing" rather than the tests for *internal* consistency, and I suspect that Popper did likewise most of the time — though he might have been amenable to an explicit fair share if confronted with this internal/external problem as the *key* issue of a debate. As it was, the matter was usually secondary to other points he was making — such as "*falsifiability*" (pages 40-44 — in which a *self-contradiction* "experience" could well serve to falsify, at least as effectively as any negative *physical* experience); but his main preoccupation there was with the *falsifiability itself*, nomatter how it was achieved.

On page 30 he had said "The theory to be developed in the following pages … that a hypothesis can only be empirically *tested* [note where the emphasis lies, while "empiric" itself seems ambiguous here] — and only *after* it has been advanced." And note that this effectively demands a trial-and-error approach. Mind you, despite his pre-eminence, Popper is not guaranteed as a permanent authority on the subject. Time brings new insights within Scientific Method, as well as within the sciences that it studies. One added concept which might be relevant is the Piaget/Ashby concept of mental stages — such that physical experimentation may be seen as an

M^0L activity, while the hunt for internal coherence would seem to be an activity of the M^1L and/or M^2L levels[1] — with each offering a meaningful "experiment" of some sort.

5.3 "Popperians" — some being blind-followers of the "Popperian formula"

Disciples sometimes miss the point of what their master actually had in mind. (There once was a doctor serving in a poorly resourced tropical area, who used the juice from *freshly*-opened coconuts as a sterile fluid. The story goes that his assistants then later tried the same, except that they thought that the key criterion was the "coconut source" and hence saved the juice for repeated use on subsequent days — with disastrous results.)

However that may be, when many scientist (or their "beancounters") talk about a new concept, they assume that "until its effects are demonstrated by *physically-tangible experiment*, it just doesn't exist". To start with that is not even in line with Popper's insistence on falsifiability-rather-than-demonstration, but instead emphasizes "the physical" which seems to be only a weak-or-incidental aspect of Popper's agenda.

Worse still, they tend to apply their concept-rejection early in the process ({1}-{4} above) — cutting innovation off at the knees — ensuring that many respectable-but-provocative hypotheses are not even taken seriously. "Continental drift" is perhaps a case in point. After a patchy background from 1596 on, it eventually appeared as a *non-wild* speculation in 1912, but it was not really taken seriously until the 1960s. It was ultimately accepted as "proved" only after costly investigations by the US Navy in the mid-Atlantic.[53,15$_{Ch.5}$]

Probably this ultraconservative blockage is mostly unintended bureaucratic malfunction, such as fundamental misunderstanding of the process, or budgets with short time-horizons. (It *might* also pay us to be on the look out for vested interests such as empire-building, or the lobbying of equipment-suppliers — but that should not distract us from trying to fix any basic confusions about the creative process).

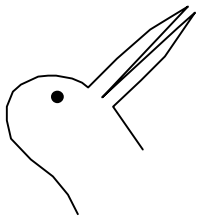
5.4 Stephen Jay Gould (2003) — and William Whewell (1840)

Gould[54] (2003, pp.210-211) quotes Whewell (1840, inventor of the word "scientist") on how Newton cobbled together his gravitation laws, starting from several ("unconnected"?) ideas: How an apple falls; How the Moon moves; and some mystical unexplained formulae from Kepler. And the resulting conclusion had no coherent rival.

Gould then goes on to point out that Whewell's protégé — a certain Charles Darwin — went on to apply the same strategy elsewhere! ["Whewell" is pronounced "Hy**ew**-(e)ll"]

5.5 Wittgenstein's Ambiguous "Duck-Rabbit"

Is Wittgenstein's image a picture of ● a rabbit looking to the left, or of ● a duck looking to the right? — Or is it indeed ● just a meaningless "doodle"? Well, in this case there is (by design) no definitely correct answer. But it does illustrate how we can build up sub-concepts and then accommodate first to one interpretation, and then to another.



Wittgenstein's duck-rabbit
(re-drawn from memory)

In real life, of course, we would look more closely, and soon clarify any such simple case. In more complex cases though, we might still have difficulty whenever the extra evidence is too difficult or too costly for us to gather it — or too complex for us to analyse it within a tolerable time-scale.

In the present paper, I have tried to draw together evidence from a wide variety of sources, and the fact that their disparate accounts seem to fit together is a good start at least. You may not be convinced (and I myself was surprised at the pro-UV conclusions which emerged) — but I do suggest

that there is enough "internal-coherence" to take the hypotheses seriously at least. Meanwhile there seems to be plenty of scope to test their implications — given the will — and given the finance!

Metaphorically speaking, I have suggested a "duck" solution (in both the IR/myelin and UV/microtubule/asbestos cases), and no-one has yet offered a coherent alternative (a "rabbit" solution) to either of them. Such alternatives may exist, but till they appear, the only other alternative is to view the present state of knowledge (on these very specific points) as being the "meaningless doodle" of an uninterpreted drawing. Of course that *might* ultimately be more correct, but at this stage it is surely better to at least have a definite target to aim at — **and test**, by all feasible means.

5.6 So when is a hypothesis "too wild" to be taken seriously?

> "…in the progress of **true** …**theories** … all the additional suppositions *tend to simplicity* and harmony; the new suppositions resolve themselves into the old ones, or at least require only some easy modification of the hypothesis first assumed: the system becomes more coherent as it is further extended. The elements which we require for explaining a new class of facts are already contained in our system. Different members of the theory run together, and we have thus a constant convergence to unity.
> **In false theories**, the contrary is the case. The new suppositions are something altogether additional; — not suggested by the original scheme; perhaps difficult to reconcile with it. Every such addition adds to the complexity of the hypothetical system, which at last becomes unmanageable, and is compelled to surrender its place to some simpler explanation. Whewell (1840), quoted by Gould [54_{p213}]. The bold-font is mine.

That sounds fine, and it is helpful — but ultimately such decisions are quite subjective, at least for hypotheses deemed to be borderline. I would like to think that the current presentation does demonstrate this sort of coherence — exhibiting enhanced "*simplicity* and harmony", at least in certain important respects. But perhaps others would be the best judge of that, as long as they attend carefully to the arguments, and avoid hasty verdicts from isolated samplings out of the pool of evidence. Likewise I think that *some* of the eight projects (#A-#H) show evidence of constructive development — even just taken on their own — but more-so when seen collectively.

Another approach is to look at textbook accounts of certain subtopics which have not progressed much over recent decades, hence consider whether that might amount to a Popperian rejection, and look round to see whether there might be plausible alternatives capable of offering *better* coherence. Albrecht-Buehler thus points to his dissatisfaction with explanations of cell biology — which motivated his "controversial" approach and eventually actual experimental findings (Project #F). Likewise it was my own dissatisfaction with the psychology/physiology interface which motivated Project #B. The question then is: Did these alternatives offer more plausible and fruitful alternatives than whatever (if anything) was there before? — at least regarding their special areas? As long as they keep producing new extensions (especially in unexpected domains) then one might suspect that the answer is "yes" — but no doubt time will tell. Finally yet another quote from the 1800s:

> *"We often discover what WILL do, by finding out what will not do;"*
> — Samuel Smiles, *Self-Help*, Ch.11, (1859).

I expect to have more to say on such matters in my forthcoming (much postponed!) paper centred on "reductionism" (www.ondwelle.com/OSM07.pdf — *when* it is ready, see [10_{p10}] footnote.)

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