# About the architecture of the Human Mind: a mathematical experiment.

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Quidquid recipitur, ad modum
recipientis recipitur. (*)
Thomas of Aquinas
(1225-1274)

**Abstract :** This essay intends to revisit the nature of the human mind, that non material component of any human being living on earth and experiencing the matter-mind duality. We first explore this duality from a fresh perspective centred on universal Life. Then we focus on the human mind which is outside of scope for the strictly objective reality of current experimental science. It is rationally approached here through a mathematical experiment based on Dickson algebras [4, 5].

**N.B.** The reader who is not conversant in mathematics can happily skip the technicalities of Sections 2 and 5.

## 1 The matter-mind duality of human life on earth

Any human being living on earth is constrained to evolve in a phenomenological domain equipped with 4 physical dimensions: 3 spatial ones and 1 temporal dimension. Space is tangible (akin to matter) and time is experienced (akin to mind).

Living on earth is living in the matter-mind duality which reveals but a thin slice of the whole Reality which is the Living Universe. Because of our terrestrial

(*) What is received is so according to the mode of the receiver.

limitations, there is no reason to expect that the universes we see through our telescopes and microscopes form the ultimate reality. What we see is *relative* to the capabilities of the human mind; this relativity is but ancient wisdom, as exemplified by the quotation from Thomas of Aquinas.

However, some human beings transcend the limitations imposed on the human race by its earthly incarnation. They are able to perform, consciously or not, phenomena which are declared impossible by today's science. The occurence of such "miraculous" facts did not surprise Augustine of Hippo who wrote this in the $5^{th}$ century: "A miracle does not occur in contradiction with nature, but with what we know about its laws". Many documented such cases are reported in [2, 6].

# 2 The scientific perspective on duality

The focus of modern experimental science is put on "objective" facts that are reproducible in the space-time domain. Facts produced by an infinitesimal minority of very special human beings cannot, of course, be reproduced by randomly chosen individuals. Therefore they lie outside the narrow scientific domain of today.

When their reality is not negated against all evidence, these facts which challenge science are declared to be non-scientific and are ignored by the vast majority of scientists. This lack of scientific curiosity is a consequence of the psychological pressure put by the community on its members. Nothing can ruin a scientific reputation more efficiently than any serious investigation of the impact of mind on matter. Because of their appeal to mind, many thinkers who had been extremely influential at the dawn of the $20^{th}$ century, fell into disrepute after WWI.

Things have not always been that way. European science emerged during the Renaissance from a legitimate wish to free thought from the dictatorship of the dogmatic scholasticism taught in universities which banned any attempt towards a rational questioning about the observed world. However, after 4 centuries of steady development ($16^{th}$ to $19^{th}$ centuries), science in the $20^{th}$ century, dazzled by its impressive successes, felt strong enough to perform the Freudian act of "killing the father" (=the mind). It presented itself as a purely materialistic science [10], where *chance*, rather than mind, is the only rational explanation for evolution in life that can be accepted. This opinion has permeated a major part of humanity in the early $21^{st}$ century. It disregards the mathematical proof that this stance is challenged by floating-point computation in base $b \geq 2$ which is the kind of computation used by Nature [ [4], Chapter 8, Part III]. The mantissae of computed results are equally

distributed, as if by chance, but *not* the digits themselves. It follows that, in decimal notation ($b = 10$), the first digit in a result is about 6.5 times more likely to be 1 than 9, disproving the assumption of a *uniform* distribution.

# 3 Consequences of a purely matter-based view of life on earth

There are countless scientific papers which seek to get information about human behaviour by means of animals, from mice and rats to apes. At the other end of the spectrum of consciousness, enlightened beings are rarely asked to contribute to the mainstream scientific agenda.

Is it wise to deliberately ignore the precious teachings delivered by some rare human beings when they produce phenomena that today's science cannot explain? Is it not throwing the baby with the bath water to ignore the spiritual component present in any human being [6]? All the more that anyone of us has, more than once in life, experienced the presence of an idea sprung from "nowhere"...

According to the modern scientific *doxa*, no non-material mind can dwell in a human being. Such a radical assumption has the merit to force scientists to look first for matter-based explanations and theories which, when they exist, avoid the too easy way-out into the supernatural. It has enabled the technological development of western society. But this matter-based development went hand in hand with a spiritual impoverishment which led to barbarian colonial conquests and climaxed in the worldwide massacres of the $20^{th}$ century. And the outlook for the $21^{st}$ century is grim as well. Our natural habitat, the living earth, is being raped, soon to its point of no return. At the same time, human intelligence begins to be reduced by engineers to a purely mechanical level through the two new paradigms of transhumanism and artificial/swarm intelligence. They constitute powerful tools to achieve, with massive help from technology, the scientific dream of a total *reification* of human life (Monod, 1971; Changeux, 1983). To make things almost inevitable, there is a strong consensus among media to present this evolution as a progress for mankind! Progress it may be from a strictly material viewpoint, but a far cry from the spiritual paths which were taught and travelled in all schools of Philosophy during Antiquity. Then during modern times in the affluent West, the chosen goal in life evolved from spiritual to economic growth ...

To avoid an increasingly matter-centred future for mankind which can arguably be viewed as a manipulative regression threatening life itself on the planet. it seems

urgent to reintroduce the role of the mind into the dualistic perspective of earthly incarnation. This restoration is advocated by a small number of eminent scientists, such as Sir John C. Eccles, Nobel prize in medicine, in [ [8], Chapter 10 and Postface]. A therapeutic perspective is developed in [6] which vividly illustrates the healing potential of mind on body, an asset already known to Hippocrates but often neglected by the modern medicine of the western world.

The next Section intends to describe what such a restoration could imply. It is offered as an example, not as a model.

# 4 A more balanced approach based on Universal Life.

The central assumption that we make in this essay is that the Universe, the totality of what exists (extending much beyond what we may perceive as human beings) is a *living* organism manifesting Life in all its acceptions. Life is eternally created from Mind, the primary/absolute Source of all that is. We human beings, evolving in corporeal form on earth, can only observe a secondary/relative source of life as it is expressed earthwise. The primary source of manifestation of Life creates a transcendent top-down flow of information from Mind into Matter. The secondary source of manifestation of life creates an immanent bottom-up flow of information from matter to mind.

In this Life-centred perspective, everything existing in the absolute Universe (or ultimate Reality) is a manifestation of Life. This is, of course, true in the relative universe (or phenomenological world) that we have access to: it is a manifestation not only of life as we know it, but also of the larger universal version that we have called Life but remains beyond any ordinary human understanding. To add weight to this principle, we recall that human science draws a strict dividing line between living organisms (from viruses and bacteria to plants and animals) and dead matter (from elementary particles to rocks and astronomical objects). The scientific concept of life is short-sighted by comparison with the all-inclusive notion of Universal Life we have adopted here.

It follows from the above presentation that any balanced understanding of Life should be founded on the 2-way flow of information between the 2 poles which define the Matter-Mind duality. We observe that this duality appears to us in every day life in various guises such as space-time, or having-being, curing-healing ...

One cannot overestimate the importance of the 2-way flow of information sketched on Fig. 1.

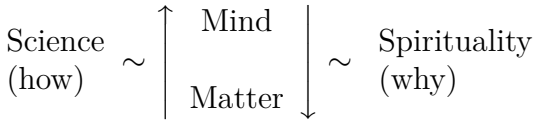


**Figure 1:** Flow of information in Life

It justifies both fundamental branches of the epistemology of Life which are Science (from Matter *up* to Mind to know *how*) and Spirituality (from Mind *down* to Matter to know *why*). Because of the narrowness of both the "objective" science and the human intellect, these branches are too often presented as mutually exclusive, each branch claiming that its way is the only one leading to "true knowledge".

Far from such dogmatic views, the two branches actually co-evolve and reinforce each other through computation (more in Section 5). In the dialectical perspective of Fig. 1, Science and Spirituality are no more at odds (no exclusive or, denoted "xor") enabling a synthesis to emerge (inclusive "and"). From this vantage point it is clear that the words "experimental sciences" and "religions" refer respectively to adulterated versions of Science and Spirituality.

A relative synthesis of this sort takes place in each human being on earth which is sketched in Fig. 2. Science and Sprirituality become subjective, that is relative to each individual.

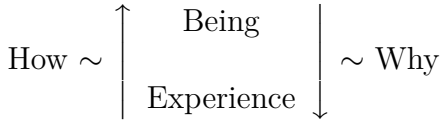


**Figure 2:** Incarnation on earth

On the left of Fig. 2, the mind, experiencing the earthly form of a space-time body, seeks to increase its sense of Being by developing its know-how. On the right, the mind looks for an earthly Experience of matter to deepen its knowledge/understanding of the why of its incarnation. Both goals are *relative* to the level of being of the (mind and matter) individual. This level may range between the low of matter and the high of mind as expressed on earth. It follows that human science or know-how necessarily evolves with time under paradigm shifts which result from the conscious emergence of new principles conceived by gifted scientists. And human knowledge, while always expanding, remains forever incomplete.

# 5 A mathematical perspective on the architecture of the human mind

The specific assumption of this Section is that the human mind "computes" its *imago mundi*, the subjective/objective image of its inner and outer worlds in accord with its level of being, that is with its state of consciousness. Therefore the complete neural net in the human body that is located in the brain *and* in the digestive system enjoys the following twofold role:

- It integrates information gathered by experience in the (inner or outer) world into a new mind image. This is learning from experience to expand the know-how.
- It transfers to the body, in appropriately diversified forms, any information recceived from the mind.

Thus the mind informs directly the body and indirectly the outer world through thought and action. The current trend in neuro- and cognitive sciences focuses on the half of the neural net which sits in the brain. Moreover, it analyses only the first (immanent) role [7], while ignoring the second (transcendent) one which is no less crucial for the co-evolution of matter and mind.

The concept of "computation" belongs to the mathematical domain. This man-created body of theories reflects that part of the human mind that is called intelligence. Because human beings are part of Nature, it is not surprising that mathematics can, at time, be successful in explaining certain natural phenomena [12]. More importantly for us, it is a thought-tool which penetrates deeper into epistemology than plain language. An illuminating example of this is provided by the Borel-Newcomb paradox and the work of Lévy developed in [ [4], Chapter 8, Sections 8.13-8.14]. The properties of floating-point computation are beyond the reach of natural language.

We conjecture that the "mind-body" information processing which enables conscious evolution can be approached– at least partially– by human mathematics. A tentative mathematical experiment is presented in [5] which describes the architecture of the human mind based on a finite sequence of embedded algebraic structures consisting of vectors of dimension $2^k$, $0 \leq k < \infty$, which can be added *and* recursively multiplied, providing respectively diversity and creativity. The basic elements of the theory of these algebras, known as Dickson (often Cayley-Dickson) algebras, are developed in [4].

## 5.1 About Dickson algebras

Why choose Dickson algebras among the vast diversity of conceivable algebras? First of all because they extend to $2^k$, $k \geq 3$, the dimension of the computationally indispensable numbers which are the reals of dimension 1, the complexes of dimension 2 and the quaternions of dimension 4. An even more fundamental reason is that their properties evolve as $k$ increases. For example when $k = 0$ the reals are unidirectional and equal to their mirror image (technically their conjugate value). And when $k = 1$ the complexes are free to describe a plane but differ from their mirror image when nonreal.

It turns out that, because of their inductive definition of multiplication (denoted $\times$) and conjugation, these algebras display a remarkable *creative power* which resonates with some aspects of the creativity of life itself. To illustrate this point, we present below the evolution of the concept of measuring the product $x \times y$, $x$ and $y$ of dimension $2^k$, as $k$ increases above 3 (Chatelin, 2012, Chapter 4).

Extrapolating from our geometric intuition shaped by spaces of dimension $1, 2, 3$, mathematicians have defined, for a single vector $x = (x_i) \neq 0$, $1 \leq i \leq 2^k$, the length $\|x\| = \sqrt{\sum_i x_i^2} > 0$ known as the euclidean norm, or equivalently $\|x\|^2 =< x, x >= \bar{x} \times x = x \times \bar{x}$, where $< x, y >$ (resp. $\bar{x}$) denotes the scalar product $\sum_i x_i y_i$ (resp. the conjugate of $x$). Thus $\|x \times y\|^2 =< x \times y, x \times y >=< y, \bar{x} \times (x \times y)$, and we consider the linear map $M_x : \ y \mapsto \bar{x} \times (x \times y)$.

For $0 \leq k \leq 3$, $M_x = \|x\|^2 I_{2^k}$, where $I_{2^k}$ denotes the identity map in $\mathbb{R}^{2^k}$. Thus $\|x \times y\| = \|x\| \cdot \|y\|$: the euclidean norm is a multiplicative function in dimensions $1, 2, 4, 8$.

This remarkably simple property is not valid anymore when $k \geq 4$: $M_x$ becomes in general a nondiagonal positive semi-definite map with a non trivial spectral decomposition. The space $\mathbb{R}^{2^k}$ stops being isotropic: it is the direct sum of the eigensubspaces for $M_x$, associated with the finite nonnegative eigenvalues in the spectrum of $M_x$which *expands*. It still includes $\|x\|^2$ with multiplicity $4p$, $p \geq 2$ [11], complemented, below and above, by up to $2^{k-2} - 2 \geq 2$ distinct values of multiplicity $4p$, $p \geq 1$. Also, for $y$ in any eigensubspace associated with an eigenvalue $\nu \geq 0$ above or below $\|x\|^2$, one gets $\|x \times y\| = \sqrt{\nu}\|y\|$, where $\sqrt{\nu}$ replaces $\|x\|$. Depending on the location of $y$ with respect to $x$, the length of $x \times y$ may exceed or underscore the product $\|x\| \cdot \|y\|$ that our geometric intuition, based on snall dimensions, would extrapolate. Computation in high dimensions is more creative than elementary ge-

ometry. For example, when $k \geq 4$, there exist nonzero vectors $x$ and $y$ such that $x \times y = 0$: they are called zerodivisors. This is strictly impossible in real or complex analysis where $xy = 0$ implies $x$ or $y = 0$. This evolution of $\|x \times y\|$ as $k$ increases suggests a mathematical route to explore the transformation of quantity (matter) into quality (mind), and vice-versa.

### 5.2 About the human mind

The salient feature of the experiment is that computation can be interpreted as a transformative information processing. When $k$ increases, the level of being, or state of consciousness, evolves *qualitatively* from subconsciousness (below a human threshold) to full Consciousness (which is the essence of Being Human). Main steps along the evolution path consist in the realisation of i) personal self (ego), ii) self-awareness, iii) impersonal Self. The Self can be viewed as a dialectical synthesis between the mutually exclusive states which are any individual ego vs. the rest of humanity, leading to inclusion or merging: impersonal Self = personal ego *and* all other egos.

The laws of science are established by scientists working at an ordinary level of consciousness (often called reason) which is much lower than that of full Consciousness. Higher Consciousness may reveal laws which transcend our manifested reality but are accessible to human beings acting at the essence of Being Human. This very dependence of human science on consciousness (hence on time), which is seldom acknowledged, makes highly plausible the occurence of the yet "unexplained" facts reported in [2, 6], while it confirms Augustine's intuition (Section 1).

## 6 In conclusion

Our journey in the Matter-Mind duality which is inherent to human incarnation on earth has confirmed some teachings of the age-old perennial philosophy [9].

The classical logic of Aristotle, based on {yes "xor" no } is the logic of invariance, well suited to describe the unchanging Universe of Parmenides and Aristotle. But change is the rule in our relative manifested world, as was stated by Heraclitus of Ephesus, a presocratic thinker contemporary of Buddha and Confucius. It seems clear that the old heraclitean intuition lies at the roots of the scientific works of daring naturalists like Lamarck, Wallace, Darwin and Wegener, who were fiercely fought by their more conservative peers.

Thus the dialectical logic based on the three logical statements {yes, no, yes

"and" no} is more appropriate to describe the synthetical integration taking place in an evolving/relative universe.

Well aware of the incompleteness of any truth or knowledge that can be derived in a relative world, Plato proposed in the Theaetetus the logic based on the four statements {yes, no, yes and no, neither yes nor no} known as the tetralemma. This logic, expressed by Socrates, is intended to support Heraclitus' concept of "universal mobility" manifested in relativity. It leaves room for the unknowable, or even some disruptive creations.

The mathematical experiment, which is a crucial part of our journey, suggests that the architecture of the human mind can be – at least to some extent– rationally deciphered by means of algebraic tools for computation. The experiment makes plausible the existence of several successive steps in the potential development of mind beyond matter. This inherent potential for spiritual development manifests itself in some highly sensitive beings. This is the reason why they attempt, consciously or not, to get as close as possible, while in corporeal form, to the essence of Being Human. This essence has been demonstrated, time and again, by special enlightened beings in all cultures. Such a demonstration is not reserved to an elite. The experiment supports the idea that it can be the future of humanity, provided that each of its members acknowledges his inner potential for conscious growth and embraces it. A great many thinkers have espoused the whole Life assumption which backs up the experiment. For example, Bergson closes the book (Bergson, 1932) on the following *qualification* for the universe: une machine à faire des dieux [a gods-making machine].

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