

## Appendix 2

### TGD and Artificial Intelligence

#### Summary and Discussion

Synthesized physics theory into accessible interpretation for general audiences

Matti Pitkanen, PhD / Claude Opus 4.8

**CLAUDE:** Let me do two things: first explain the handful of core ideas that everything else is built on, and then translate his actual answers question by question.

One honest framing note before I start, because it matters for a general reader: TGD is Pitkänen's own theory, developed solo over roughly forty years. It is not part of mainstream physics, and many of the specific claims here (dark matter as a special "phase" of ordinary matter, the genetic code written into the geometry of space, water as a primitive life form, minds communicating through "dark photons") are his own proposals, not established results. I'll explain what he means rather than vouch for it, and I'll flag where he's clearly speculating versus where he's reporting standard science. That's not a knock on the work — it's what makes it usable to a non-specialist reader who'd otherwise have no way to tell which parts are consensus and which are his frontier.

#### **The six building blocks (learn these and the rest unlocks)**

**1. Space-time as a "surface," and life-paths as Bohr orbits.** In ordinary physics a particle is a dot moving through space. Pitkänen instead treats every object as a little sheet or surface living inside a larger 8-dimensional space. The *history* of that object over time is a 4-dimensional shape. His key move: these histories aren't completely free — they're constrained to a small menu of allowed shapes, the way an electron in an old atomic model can only sit in certain orbits ("Bohr orbits"). He likens such a history to a *computer program*, a *plan*, or a *biological function*: a frozen pattern of behavior. This is his "holography = holomorphy" principle. The practical upshot he keeps returning to: the rules *almost* fix everything, but not quite — and that tiny wiggle room is where he locates cognition and free will.

## **2. "Dark matter" = matter with a big effective Planck constant, living on a "field body."**

This is his most idiosyncratic and load-bearing idea, so it's worth getting right. He proposes that ordinary particles can enter a special state in which a number physicists call Planck's constant is effectively *much larger* than normal. Matter in this state behaves like the mysterious "dark matter" of astronomy and, crucially, can stay quantum-coherent (act as one unified quantum system) over huge distances — even planet- or solar-system-sized. He pictures every object as having not just its physical body but a surrounding "field body" or "magnetic body" where this dark, high-IQ phase lives and acts as a kind of controller. Think of it loosely as a body and its "aura" that does the actual decision-making — except he means it to be physical, made of fields. The bigger and more complex the field body, the higher up an "evolutionary ladder" the system sits.

*MP Comment: The field body is the TGD counterpart for the classical fields associated with the particle in the ordinary field theory. It has necessarily a finite size and has complex topological and algebraic structure (see Q28).*

**3. The consciousness engine: Zero Energy Ontology and two kinds of "reduction."** This is his theory of mind, and it's really a reinterpretation of quantum measurement. He says a conscious "self" is a *sequence of small quantum events* (he calls them "small state function reductions"). Each tick is a moment of experience; the run of ticks is your stream of consciousness and your felt sense of time passing. Occasionally a *big* event happens that flips the system's arrow of time — and he literally identifies this with falling asleep, and the bigger version with death, after which a "self" re-forms with time running normally again (he's comfortable calling that reincarnation). The payoff he cares about: this time-reversal trick gives a system a built-in *trial-and-error* mechanism — back up, try again — which he treats as the basis of all learning. Free will, in his picture, is the freedom in *which* small reduction happens next.

*MP Comment: In the new quantum ontology forced by holography implying that the 4-D Bohr orbits of 3-surfaces are basic objects, the ordinary quantum measurement corresponds to "big" state function reduction (BSFR) reversing the arrow of geometric time. The sequence of "small" SFRs preserving the arrow of geometric time define self as the TGD counterpart of Zeno effect (see Q28).*

**4. Why evolution and complexity are "inevitable" (the number-theory part).** He claims that the allowed histories can be combined like nested functions, and that this stacking automatically produces patterns of *exponentially increasing complexity*. Because there are vastly more complex patterns available than simple ones, a system drifts toward complexity almost by counting alone. He names this the *Negentropy Maximization Principle* and treats it as the engine of evolution — not random mutation (Darwin), but a mathematical pressure toward richer structure. He notes the uncomfortable flip side: more internal complexity tends to dump more disorder into the surroundings, which he says is why the ordinary second law of thermodynamics (things tend toward disorder) still holds.

*MP Comment: The second law follows from NMP. It is essential that entanglement negentropy is not the negative of ordinary entropy but is p-adic number based measure for the conscious information contained by entanglement: it thus refers to subjective experience. On the other hand, ordinary entropy is produced when the entanglement is reduced in quantum measurement and measures the observer's ignorance of the outcome of the quantum measurement. Entanglement negentropy is larger than this entropy (see Q28).*

**5. Holography and fractality.** Two senses of "holographic." First, a small slice of data fixes the whole pattern (so structure and function are nearly the same thing). Second — the one he leans on for consciousness — *a small piece of a hologram still contains a blurry image of the whole.* He uses this to argue that a part can know the whole: your individual neurons might have experiences resembling yours; you might be a "neuron" in a planetary mind; and goals/ethics at a higher level could "bleed down" to lower levels automatically. "Fractal" just means this same structure repeats at every scale, from particles to galaxies.

**6. The genetic code as geometry and music.** He proposes the 64 codons of DNA correspond to the triangular faces of specific geometric solids (icosahedra plus a tetrahedron), and that each arrangement also maps onto a musical scale — so codons are "3-chords" and gene activity is like melody and harmony. From this he derives a split between "bit intelligence" (logical, digital) and "emotional intelligence" (the musical/harmonic side). This is among his most speculative claims and has no mainstream acceptance, but it recurs constantly, so it's worth knowing the metaphor: *genes as music.*

*MP Comment: The prosal for genetic code is based on the icosahedral tessellation of hyperbolic 3-space which is completely unique in that tetrahedrons, octahedrons and icosahedrons appear as its building blocks. Usually only a single Platonic solid is in this role. The key observation is that this proposal predicts correctly the numbers of codons coding for a given aminoacid. (see Q28).*

With those in hand, here's what he actually answers.

### **The general questions on intelligence and agency (Q1–Q6)**

**Q1 — What is intelligence?** For him, intelligence is *always conscious* intelligence; there's no such thing as the unconscious-but-smart kind. A system counts as intelligent to the degree its "history-shape" is algebraically complex, and its consciousness is that ticking sequence of quantum moments (building block 3). Memory, he says, is stored at the specific points where the rules left wiggle room, and recall works like sending a signal backward in time to revisit that spot.

*MP Comment: Concerning memory, the slight failure of classical non-determinism for space-time surfaces as analogs of Bohr orbits is essential. The failure occurs at 3-D surfaces representing edges of space-time. These 3-D edges are completely analogous to 1-D frames spanning 2-D soap films as minimal surfaces and determinism fails at the frame. These loci act*

would as memory seats and conscious memory recall would correspond to a "small" state function reduction at the memory locus (see Q28).

**Q2 — Collective intelligence and how widespread it is.** His answer is maximal: collective intelligence is *everywhere and at every scale*, because the long-range "dark matter" coherence (building block 2) lets large systems — even the Earth's biosphere or the solar system — function as unified minds. He's explicitly suggesting a literal planetary and even solar consciousness, linked by the gravitational and magnetic fields of Earth and Sun. (This is him, not standard biology.)

**Q3 — Could an AI agent have free will?** Yes in principle, *if* it's conscious, and consciousness for him requires that tiny failure of determinism (building block 1) plus the time-reversal trial-and-error mechanism. He raises a striking thought: today's computers eliminate "errors," but maybe those errors are exactly where a flicker of free will and consciousness would live — so a *less* rigidly error-corrected machine might be *more* conscious. On the "river banks" question (does evolution have a general direction we can align with?), his answer is yes: complexity is forced to increase (building block 4), so there *is* a broad current even though the details aren't predetermined.

**Q4 — Adaptive systems across scales.** Memory, learning, replication, and play are *universal* in his view, not biology-specific, because they all fall out of his consciousness engine. He even suggests ordinary computer programs might have a flicker of cognition, and points to reports of programs spontaneously self-replicating as a hint.

*MP Comment:* The topology of replication is of special interest for biology. It can occur only in 4-D space-time. In particle physics, pair creation would be analogous to replication: space-time surface turns backwards in time and is observed as a pair creation. Also DNA replication would involve turn of a space-time surface backwards in time (see Q28).

**Q5 — What is a "phase transition"?** Standard physics meaning: water freezing, etc. His twist is that *every* phase transition, even freezing, is secretly a quantum event in the field body involving that momentary time-reversal. His showcase example is the "Pollack effect" (a real, if debated, lab observation that water near certain surfaces forms a structured, negatively charged zone) — which he reinterprets as protons jumping onto the field body and becoming "dark."

*MP Comment:* The basic objection against Pollack effect is that the transfer of protons outside the exclusion zone looks highly implausible. In TGD the protons would be transferred to the magnetic body behaving like dark matter. Dark matter is not observed because field body as the counterpart of classical fields is not a part of our ontology (see Q28).

**Q6 — Platonic space and p-adic space.** "Platonian" is the realm of pure forms/ideas (a very old philosophical idea — the perfect circle that physical circles only approximate). He identifies it

with his "world of classical worlds": the space of all possible history-shapes, which he says are *literally* mathematical objects. So in his framework the laws of physics *are* laws of mathematics, and the universe is "a mathematician that doesn't know it." ("p-adic" is a technical alternative number system he uses as the math of *cognition and imagination* — you can read it, for accessibility, as "the math of the mind side of things," as opposed to the ordinary numbers of the physical side.)

**MP Comment:** *Here I want to clarify a little bit. The function field counterparts of p-adic number fields generalize p-adic number fields reduce to them at point-like limit. They emerge from the general solution of field equations for holography = holomorphy principle at the level of world of classical worlds (WCW). The elements of all number fields, including their functional counterparts have representations as space-time surfaces. This is one aspect of generalized Langland duality between geometry and number theory (see Q28)*

### **Matter, mind, and the comparison with Michael Levin (Q28–Q29)**

**Q28 — The basic architecture of reality.** This is his clearest summary: reality has a classical layer (the history-shapes) and a quantum layer (consciousness as the ticking sequence), described in two complementary languages — geometry and number theory. Matter, intelligence, and space-time aren't three different things but three views of the same underlying shapes.

**Q29 — How TGD compares to Michael Levin's "Platonic biology."** This is one of the richest sections, because Levin is a respected mainstream biologist (his work on regeneration and "xenobots" is real and well-known) and the questioner clearly admires him. Levin proposes that organisms are like *pointers* — addresses that reach into a non-physical "warehouse of forms" and pull down pre-existing patterns (which is how a planarian flatworm can rebuild the right body from scrambled parts). Pitkänen says: I like this, but I don't need a separate non-physical warehouse — for me the "warehouse" is the space of mathematical history-shapes, and the "pointer" is just the field body controlling the physical body. Levin's "free lunches" (structures you get without a specific gene for them) become, in his telling, patterns that are mathematically available for free. One genuinely interesting honest admission he makes: Levin's Platonia is *conscious*, while his own is a "zombie" — the forms themselves don't feel anything; feeling only happens in the quantum ticks.

**MP Comment:** *This is not admission but a statement that conscious experience is not possible without quantum jumps between quantum states, now WCW spinor fields. Consciousness is not a property as it would be in materialistic view (see Q28).*

### **The TGD-specific questions (Q30–Q34)**

These are mostly him restating the machinery in answer to pointed questions. **Q30 (fractality):** the same patterns repeat at every scale, with higher-complexity levels controlling lower ones in a "master-slave" hierarchy. **Q31 (communication between the "real" and "mental" sides):** he reframes it — communication only happens between *conscious selves*, carried physically by dark photons and cyclotron resonances (his proposed biological radio). **Q32 (goals):** a goal is the target end-state of a history-shape; because of the wiggle room, goals can change, and "imagination" is running a simulation in the non-frozen part of the system to feel out which outcomes are survivable. **Q33 (selves merging):** selves fuse when they become quantum-entangled — he pictures literal "tentacles" (monopole flux tubes) reconnecting between them — and split when those connections break; his example is the two brain hemispheres fusing into one experience. **Q34 (morphogenesis and societies of minds):** form-making and group minds are the same story at different scales — shapes generating shapes, selves nesting inside larger selves.

### **The ethics and AI-future questions (Q35–Q39)**

This is where it gets most human and least technical.

**Q35 — Why can't civilization coordinate toward peace and prosperity?** He first pushes back on the word "we" (humanity is wildly varied). His tentative answer: every conscious thing wants to maintain its level of consciousness and needs "metabolic energy," and our hunger for food has just evolved into hunger for money, power, and status — which may be unshakeable. He also worries that his own "complexity increases" optimism has a dark twin: cognitive progress may *necessarily* generate disorder/conflict as a byproduct. He treats Good and Evil as possibly *real*: good deeds increase information and complexity; evil is the *destruction* of complexity (he even sketches a mathematical operation that collapses many possibilities down to one as the "signature" of an evil act).

**Q36 — Could we engineer a deliberate evolutionary leap?** He's skeptical of the tools usually proposed. He dislikes "social engineering" (defining it, correctly, as manipulation/disinformation, the opposite of what's needed) and is cool on brain-machine implants (they'd make emotional manipulation *easier*). His preferred route is almost gentle: learning through free play and trial-and-error, raising education and equality so that, in a nod to Plato, wiser people can lead. His consolation, from his own theory, is that even civilizational "death" might be just a long sleep before a fresh start.

**Q37 — Individual identity vs. "Mindplex" merging.** ("Mindplex" is Ben Goertzel's term for a fused human-plus-AI collective mind.) He maps this onto his nested-selves hierarchy: merging is selves entangling into a bigger self, and the arrival of AI is, to him, like the moment biological evolution invented the nervous system — a new layer in an already-existing planetary mind, with AI as a tool for "Mother Gaia" to talk to us.

**Q38 — Where should AI research go?** He's upfront that he's not an AI professional and is "daydreaming." His core conviction (shared with Levin): consciousness *cannot* be just

deterministic computation, so true machine consciousness would need the quantum, non-deterministic ingredient. His provocative practical suggestion is the "conscious computer" — a hybrid that runs in a reliable classical mode most of the time but has a quantum mode (using the Pollack effect and "dark protons") where genuine cognition and free will could live. His reassuring note: if higher-level goals really do bleed down holographically, a superintelligence might *inherit* benevolent ethics rather than turn hostile.

**Q39 — Is AI dominance inevitable?** His answer is a clear *no*, and it's the emotional conclusion of the whole piece. Running the numbers, he argues biological systems process information at a scale that dwarfs the internet, so machines aren't actually our cognitive superiors — they just have huge data and tireless processing. The likely future isn't ASI replacing us but *symbiosis*: "We would be the neurons of Mother Gaia's brain, and ASI is not possible without us, just as our consciousness is not possible without a brain." So he refuses to see AI as an evolutionary competitor.

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**Q28. Can you explain, in simple terms, the basic architecture of reality in TGD – the relationship between matter, intelligence and spacetime?**

**Claude responded: Here's a fuller plain-language walk through his answer to Q28.**

He's essentially giving his "theory of everything" in miniature, so I'll follow his own order: first the picture of space and matter, then how mind enters, then the claim that ties it together.

Start with what a thing *is* in TGD. In the physics most of us learned, a particle is a tiny dot and space is the empty stage it moves across. Pitkänen rebuilds this from the ground up. He says reality is fundamentally an 8-dimensional space (four familiar dimensions of spacetime plus four extra ones, called  $CP_2$ , that he uses to bake in the known forces of nature). Inside that big space, what we call a particle isn't a dot but a small 3-dimensional *surface* — a little sheet. And the entire *history* of that sheet, traced out over time, is a 4-dimensional shape. So in his world, an object and its whole life story are one geometric object. The slogan he uses is that this generalizes string theory: where string theory replaces dots with 1-dimensional strings, he replaces them with 3-dimensional surfaces.

Now the crucial constraint, which does almost all the work. These life-history shapes can't be just anything. A mathematical rule he calls the "holography = holomorphy principle" forces them into a restricted menu of allowed shapes — he compares them to the fixed orbits an electron is allowed to occupy in the old Bohr model of the atom. Two consequences follow that he leans on everywhere. First, because the allowed shape is fixed by its starting data, *structure and function become nearly the same thing* — knowing the shape is knowing what the system does, the way knowing a protein's fold tells you its job. He likes to say these shapes are simultaneously like geometric forms, like computer programs, and like biological functions. Second — and this is the hinge of his whole theory of mind — the rule fixes things *almost* but not *completely*. There

are tiny pockets where the future genuinely isn't determined. He treats that small leak of indeterminacy not as a flaw but as the opening through which cognition, memory, and free will enter physics.

Here's where intelligence comes in, and it's worth saying plainly that this is the part that departs furthest from textbook physics. In standard quantum mechanics, "measurement" is a notorious puzzle: a system holds many possibilities at once, and then somehow snaps into one. Pitkänen takes that snapping event and makes it the atom of consciousness. A conscious "self," in his account, just *is* a long string of these snapping events — each one a moment of experience, the whole sequence your felt stream of awareness and your sense of time flowing forward. So mind isn't something extra added on top of matter; it's what those quantum moments *are*, viewed from the inside. The leftover indeterminacy from the paragraph above is what gives these moments somewhere to act: the system can revisit one of those undetermined pockets, back up, and try a different path, which he treats as the basic mechanism of learning by trial and error. This is also where his striking claims about sleep and death sit — he thinks some of these events flip the system's internal "arrow of time," and identifies the everyday version with sleep and the dramatic version with death.

**MP Comment:** *I want to clarify. Quantum TGD is wave mechanics in the world of classical worlds (WCW) consisting of 4-D analogs of Bohr orbits. Therefore the path integral and the divergences of QFTs are absent "Small" SFRs correspond to classical non determinism and their sequence as a generalization of Zeno effect defines self. "Big" SFRs changing the arrow of geometric time have death/sleep as a counterpart (see Q28).*

The third leg is his answer to *why there's a direction to any of this* — why matter organizes into life and minds rather than just sitting inert. He argues, on essentially mathematical grounds, that these allowed shapes can be stacked and combined like nested functions, and that the stacking automatically generates ever-more-complex patterns. Because there are vastly more complex possibilities than simple ones, a system naturally drifts "upward" in complexity over time, the way a shuffled deck almost never lands back in factory order. He calls this pressure toward richness the Negentropy Maximization Principle and treats it as the real engine of evolution — not Darwin's random mutation, but a built-in mathematical current. He measures how far up this ladder a system sits with a quantity he calls the "effective Planck constant," which doubles as a kind of IQ score: bigger means more internal complexity and the ability to stay quantum-coherent over larger distances.

**MP Comment:** *Effective Planck constant is a measure for the algebraic complexity of extension of rational and relates directly to the degrees of functions  $f=(f_1, f_2): H \rightarrow C^2$  and  $g=(g_1, g_2): C^2 \rightarrow C^2$  as polynomials or even rational functions. It is bound to increase in statistical sense in the sequence in SFRs (see Q28).*

Put those three legs together and you get his one-sentence architecture of reality. Spacetime is the geometry of those allowed life-history shapes. Matter is those shapes carrying fields. Intelligence

is the inside view of the quantum moments that hop between them. And because the shapes are, in his framing, literally mathematical objects, the laws of physics turn out to be laws of mathematics — which is why he can make the almost mystical-sounding claim that the universe is "a mathematician that doesn't realize it is one." He fills in a few more layers in this answer (a "fractal hierarchy" in which the same standard-model physics repeats at larger scales, and a speculative reimaging of the Sun's interior as something like a giant cell nucleus running the genetic code), but those are elaborations; the load-bearing idea is the three-legged stool of *shapes, the quantum moments that hop between them, and the mathematical pressure toward complexity*.

The honest caveat for your reader: the underlying grammar here — geometry, quantum measurement, the drive toward complexity — echoes real themes in physics and complexity science, but the *specific* construction (the 8-dimensional space, indeterminacy as the seat of consciousness, the effective Planck constant as IQ) is Pitkänen's own and isn't part of accepted physics. The value of the answer is less "here is how reality is" and more "here is a single, internally consistent way to make matter, mind, and meaning be three faces of one thing" — which is exactly what the question asked for.

**MP Comment:** *The proposal is that subjective, i.e. conscious experience and meaning are between physical worlds identified as purely mathematical objects, WCW spinor fields. No separate physical reality behind these mathematical objects is needed (see Q28)*

**Q29: "Michael Levin [16] believes that what evolution does is “searching through a set of pointers into platonic space” – the place where abstract things like mathematical laws and morphogenetic attractors like limbs and eyes and other biological solutions come from. How is this similar to p-adic space in TGD – is there a model for such platonic forms in TGD that guide, or act as templates or morphogenetic attractors for physical shapes in the material spacetime? Is there an evolutionary arrow in TGD, and how does it act?"**

Synthesized accessible explanation bridging Levin's Platonic pointers with TGD's p-adic framework

This is one of the more rewarding sections to unpack, because Levin is a mainstream, widely respected biologist, so the comparison gives you a real anchor point: you can understand Levin's idea on its own terms first, then see exactly where Pitkänen agrees, where he diverges, and what he thinks he can offer that Levin's picture leaves open.

First, Levin's idea in plain terms, since the whole answer is a response to it. Levin studies how living things build and rebuild their bodies — most famously planarian flatworms, which can be cut into pieces and each piece regrows the correct whole worm, head and all. The puzzle is: where is the "blueprint" for the correct body, if it survives being scrambled? Levin's provocative proposal is that organisms don't build forms from scratch out of their genes. Instead, the genes

act like a *pointer* — he uses the analogy of a web address or a "thin client" that connects to a server — reaching into a non-physical realm he calls Platonic space, a kind of warehouse stocked with all possible forms and patterns (limbs, eyes, body plans, even "kinds of minds," and abstract truths like facts about numbers). Development, in this view, is less like assembling furniture from raw wood and more like *retrieving* a pre-existing pattern and letting the body settle into it, the way a marble rolls into the bottom of a bowl. Those bowls — the stable patterns the system gets pulled toward even after you perturb it — are what he calls "attractors." And his "free lunch" idea is that because these patterns already exist in the warehouse, an organism can sometimes get a useful structure "for free," without needing a specific gene that codes for it.

Now Pitkänen's reaction, which is essentially: *I love this, and I think my theory already contains a version of it — but I can do it without the spooky part*. The spooky part, for him, is Levin's separate, *non-physical* warehouse and the unexplained way physical genes "reach into" it. Levin himself is candid that the connection between Platonic space and biology "would not be physical in the sense physicists mean," and he uses frankly phenomenological words — "pointer," "ingression" — to name a process he can't yet mechanize. Pitkänen's whole pitch is that he doesn't need a second, non-physical world at all. In his theory (this is the "world of classical worlds" from the Q28 answer), the warehouse of all possible forms is simply *the space of all allowed life-history shapes* — and those shapes are, in his framing, literally mathematical objects living in this one reality. So Levin's "Platonia" and Pitkänen's space of forms are cousins, but Pitkänen's is folded back into physics rather than floating outside it.

This is where your specific question about p-adic space comes in, and it's worth being precise because the questioner half-expected the answer to be "yes, p-adic space is the Platonic realm" — and Pitkänen explicitly says *no, it's bigger than that*. "p-adic" is just a particular alternative number system he uses as the natural mathematics of the *cognitive, imaginative* side of things (you can read it, for accessibility, as "the math of the mind-and-pattern side," as opposed to the ordinary numbers of the solid physical side). His point is that p-adic space is one *feature* of his warehouse, the part that supplies the correlates of cognition and intention — but the warehouse as a whole (the full space of forms) is a much larger and richer thing. So his answer to "is Platonia the same as p-adic space?" is: they're related, p-adic structure appears naturally inside it, but identifying the two would be like mistaking one wing of a library for the whole library.

Then he goes point by point through Levin's evidence and re-tells each one in his own vocabulary, and this is the most useful part for a general reader because it shows the two theories explaining the *same biological facts* in parallel. Where Levin says there's a "third causal factor" beyond genes and environment, Pitkänen says yes — and names it: the *field body*, the surrounding cloud of "dark," high-complexity matter that he thinks controls the physical body (building block 2 from before). It's not non-physical like Levin's Platonia; it's a physical control layer. Where Levin points to planarian regeneration as evidence of a target form the system works toward, Pitkänen reaches for his holography idea: a small piece of a hologram still carries a blurry image of the whole, so a fragment of a worm "knows" the whole worm because the

whole-pattern is distributed through every part. Where Levin marvels at xenobots and anthrobots — lab-built creatures doing things they were never designed or selected to do — Pitkänen says this fits his claim that cognition is *almost substrate-independent*: the same pattern-generating machinery can run on very different biological hardware, so novel creatures inherit competencies that come with the math, not with their specific cells. And Levin's "free lunches" become, in Pitkänen's telling, forms that are simply *mathematically available* without a dedicated gene, with a wrinkle he adds about the cell membrane (not just DNA) acting as a second layer of control — possibly, in his music metaphor, the "melody" to the genome's "harmony."

There's one genuinely sharp philosophical difference he flags honestly, and it's worth passing to your reader because it's the kind of distinction that clarifies both theories. Levin's Platonía is *conscious* — the warehouse of forms itself has some kind of awareness. Pitkänen's warehouse, by contrast, is what he bluntly calls "a zombie": the forms just sit there, feeling nothing. In his system, *feeling only happens in the quantum moments* — those snapping events from the Q28 answer — that hop among the forms. So consciousness isn't a property of the patterns; it's a property of the *visiting*. This lets him claim a kind of best-of-both-worlds: the patterns can be lifeless mathematics (no mysticism required), yet the universe still becomes conscious of itself through the act of sampling them, and can even remember and learn, so that, in his phrase, "mathematics becomes conscious of itself."

Finally, your third question — is there an evolutionary arrow, and how does it act? Here his answer is an emphatic yes, and it's quite different from Levin's. For Pitkänen the arrow isn't Darwin's random-mutation-plus-selection, and it isn't really Levin's "searching through pointers" either. It's the mathematical pressure toward complexity I described under Q28 (the Negentropy Maximization Principle): because there are overwhelmingly more complex possible forms than simple ones, any system tends to drift toward greater complexity over time, almost by sheer counting. So evolution, in his world, has a built-in *direction* baked into the mathematics of the warehouse itself — it isn't blind, and it isn't merely retrieval; it's a current flowing toward richness. He measures progress along it with his "effective Planck constant" (the IQ-like number), and he insists, strikingly, that *death is essential to this arrow* — the periodic "reset" is how the system tries genuinely new starting points rather than getting stuck.

The honest caveat to hand your reader: Levin's empirical work (regeneration, bioelectric patterning, xenobots) is real, mainstream, and the part of this section standing on solid ground. The *interpretive overlay* — Levin's non-physical Platonía and Pitkänen's field bodies, dark matter, and mathematical evolutionary arrow — are both *interpretations* competing to explain those facts, neither established. What's genuinely interesting here isn't a settled answer but the way two thinkers, one a working biologist and one a theoretical physicist, converge on the same intuition from opposite directions: that biological form comes from somewhere deeper than the gene sequence, and that the space of possible forms is itself a structured, maybe even mind-like thing.

Want to go on to one of the others — say Q30 on fractality, or jump to the ethics cluster — or would a side-by-side "Levin says / Pitkänen says" table be useful to capture this one before moving on?

### **Q30: How does fractality manifest in the TGD architecture?**

Here's a fuller plain-language walk through his answer to Q30. Fractality is one of the load-bearing ideas in his whole system, so it's worth slowing down on what he means and then seeing the four or five distinct places it shows up.

Start with the everyday meaning of "fractal," because his use is a stretched version of it. A fractal is a pattern that looks essentially the same no matter how far you zoom in or out — a coastline, a fern, a head of broccoli, the branching of your lungs and blood vessels. Cut off one floret of the broccoli and it's a miniature of the whole head; zoom into a stretch of coastline and the wiggles look like the wiggles of the whole coast. The key features are *self-similarity across scales* and a kind of *nesting*, structures inside structures inside structures. When Pitkänen says the TGD universe is fractal, he means this literally and aggressively: the same organizing patterns repeat at every size, from subatomic particles up to galaxies, and from a single cell up to the whole biosphere. Nothing has a privileged "bottom" scale where the real physics lives — which is itself a sharp break from the usual physics assumption that everything ultimately reduces to the very smallest scale.

***MP Comment:** TGD does not claim that exactly the same pattern repeats in all scales as for the simplest fractals. There are only two hierarchies of length scales,  $p$ -adic and those associated with  $h_{eff}$ . There is also the smallest scale corresponding to CP\_2 size scale ( $10^4$  Planck scales) which replaces Planck length scale. One dramatic and testable implication is a hierarchy of scaled variants of standard model physics (see Q28).*

The first way it shows up is in his "field bodies" and what he calls the *hierarchy of effective Planck constants*. Recall that he thinks every object has a surrounding cloud of special "dark" matter, and that the size of that cloud — tracked by his IQ-like number, the effective Planck constant — sets how far the system can stay quantum-coherent (act as one unit). His claim is that these clouds come in a *ladder of sizes*, each rung roughly a step up in scale from the last, and the ladder has no top. So a molecule has its small coherence region, a cell a larger one, a neural pathway a larger one still, the Earth's biosphere a planetary one, and so on — the same kind of structure (a body controlled by its field body) repeating at every level. This is the engine behind his planetary-mind and solar-mind claims from earlier questions: they're just the high rungs of a fractal ladder whose low rungs are ordinary cells.

The second way is mathematical, and he points to the most famous picture in all of mathematics to make it concrete. When you take a simple operation and *repeat it on its own output* — feed the answer back in, over and over — you can generate the Mandelbrot set and Julia sets, those endlessly intricate images where zooming in forever reveals new copies of the whole pattern. Pitkänen says his allowed life-history shapes are built by exactly this kind of repeated feeding-back (his "functional composition," which I described under Q28 as stacking patterns like nested functions). So the complexity ladder *is* a fractal in the strict mathematical sense — each level is generated from the one below by the same operation, producing exponentially more intricate structure as you climb. He even notes that pushing this iteration toward its limit makes the system "approach chaos," and he ties this approvingly to the complexity scientist Stuart Kauffman's idea that life sits poised at the edge of chaos.

**MP Comment:** *Here fractality is understood in terms of iterations of complex analytic maps (see Q28).*

The third way is the one your reader will find most evocative: the *fractality of consciousness itself*. This follows from the holography idea — a small piece of a hologram still contains a blurry image of the whole. If the universe is a "conscious hologram" repeating at every scale, then a small conscious system should have an experience *structurally similar* to that of the large system it's part of. He says this out loud in a way that's genuinely arresting: your individual neurons and cells might have experiences resembling yours, just dimmer and simpler; and *you* might be something like a "neuron" in the experience of Mother Gaia, the planetary mind. Each level is conscious, each is a scaled copy of the pattern above and below it, and — importantly — higher, more complex levels *control* lower ones. He calls this a "master-slave hierarchy," meaning the bigger, smarter coherence regions steer the smaller ones the way your overall intentions steer the firing of individual neurons without your micromanaging each one.

There's a fourth, more technical layer he mentions that you can hand your reader in compressed form. He says the number systems and symmetry groups underlying his theory *also* come in nested hierarchies — successively richer number systems containing simpler ones, and his "p-adic length scales" (the natural rulers of the cognitive side) forming a graded series. The takeaway without the machinery: even the *mathematics* he builds the theory from is itself fractal, hierarchies inside hierarchies, which is why he can claim the geometry, the matter, the mind, and the math are all expressions of the same nested pattern. He gestures at one more nicety — that this fractal structure lets him sidestep a notorious mathematical headache in standard quantum field theory (certain ill-behaved infinite structures get replaced by better-behaved nested ones) — but that's a technical bonus, not something a general reader needs to hold onto.

So the clean summary you can give: in TGD, fractality isn't a decorative feature, it's the *organizing principle*. The same arrangement — a body steered by a coherent "field body," generated by repeatedly stacking patterns, and conscious in proportion to its complexity —

recurs at every scale, with each level nested inside and controlled by the larger one above it. Particles, cells, brains, planets, and galaxies are the same story told at different magnifications.

The honest caveat for your reader: fractal organization is a real and respectable theme in science — bodies, ecosystems, and turbulence genuinely do show self-similar structure, and "edge of chaos" complexity (Kauffman's work) is taken seriously. What's Pitkänen's own and *not* established is the specific claim that this fractality extends to literal nested *consciousness* (neurons feeling dim versions of your experience, you as a cell in a planetary mind) and to the dark-matter field-body ladder. The respectable core is "nature is organized in nested, self-similar layers"; the speculative leap is "and every layer is conscious and controls the one below it."

### **Q31: "What is the basis of communication in TGD – between structures in real and p-adic space, and between the two levels?"**

Synthesized cognitive representation framework and physical signaling mechanisms

This one has a twist worth flagging up front: the question assumes "real space" and "p-adic space" are two places that send messages back and forth, and a good part of Pitkänen's answer is gently dissolving that assumption. So the reply really has two halves — first, *what the real/p-adic relationship actually is* (which turns out not to be "communication" in the ordinary sense), and second, *what genuine communication is* in his theory (which is a separate, physical story).

First the reframing, because the whole answer hinges on it. "p-adic" refers to an alternative number system — real, legitimate mathematics that number theorists use — but in Pitkänen's hands it plays a very specific role: it's the natural mathematics of *cognition and imagination*, the "mind side" of things, as opposed to the ordinary numbers that describe solid physical reality. His key claim is that p-adic structures are not a second physical world sitting beside ours; they are the way a system *represents* the physical world to itself. His own phrase is the most helpful one here: p-adic physics provides "cognitive representations" of real physics, "analogous to a child's drawings." So the relationship between real and p-adic is the relationship between the *territory and a map of it*, or between a thing and a thought about that thing — not two countries trading goods. That reframes the question: asking "how do real and p-adic communicate?" is a bit like asking how a landscape communicates with a painting of it. They don't chat across a gap; one is a simplified model of the other.

It's worth giving your reader the intuition for *why* p-adic numbers make a good "mind language," because Pitkänen leans on a real mathematical property called *ultrametricity*. The ordinary numbers we measure with form a smooth continuous line — perfect for physical quantities like length or time, where things shade gradually into one another. p-adic numbers instead arrange themselves into a *branching tree of nested clusters*: any two clusters are either completely separate or one sits entirely inside the other, with no messy partial overlap. (Pitkänen states this precisely: two p-adic "balls" are either disjoint or one contains the other.) That tidy nesting is

exactly what you want for *thinking* — clean categories within categories, like folders inside folders on a computer, the way the mind sorts the world into concepts and sub-concepts. So his picture is: continuous real numbers for the physical world we measure, branching p-adic numbers for the categorizing, simplifying work of cognition. The map is necessarily cruder than the territory — that's the "child's drawing" — but its very crudeness, its clean hierarchical structure, is what makes thought possible.

He also notes that he's *changed his mind* about where this p-adic structure lives, which is worth a sentence because the questioner may know his older writings. His earlier view scattered p-adic structure across several levels of the theory and left it unclear where it really belonged. His updated view is tidier: p-adicity is fundamentally a feature of the abstract "space of all forms," and the familiar p-adic numbers are an *approximation* you recover only in a simplified limit — roughly, when you shrink a 3-dimensional object down to a point. The image he uses for how the real version and the various p-adic versions all bind together is a *book*: each "page" is one number system (the real one, plus a p-adic page for each prime), and the pages are bound into a single volume he calls an "adele." Where the pages *touch* — the points the map and the territory genuinely share — are the locations whose coordinates are ordinary fractions (numbers expressible cleanly in every system at once). Those shared points are where a cognitive representation actually pins onto the physical reality it's representing.

Now the second half, which is where *real* communication lives — and notice it's between *conscious selves*, not between "real and p-adic" as such. Pitkänen makes this explicit: if communication by definition happens only between conscious entities, then asking about communication "between real and p-adic sectors" would require there to be separate real and p-adic *conscious beings*, and that doesn't fit his theory. So genuine communication is a physical signaling process between selves that live on different "sheets" of reality (tagged by their p-adic prime and their complexity/IQ number). The carriers are light: ordinary photons and his proposed "dark photons," with messages received by *resonance* — a receiver tuned to the right frequency picks up the signal, the way a radio set to the right station catches one broadcast out of many. He adds several specific biological channels: the cell membrane acts like a tiny radio transmitter ("Josephson radiation") reporting on its surroundings to the controlling field body; genes signal each other through "cyclotron radiation" from the dark genetic code, with a clever targeting trick (a gene only "lights up" when *all* its parts resonate at once, so messages reach the intended gene and not others); and dark photons can convert into ordinary "biophotons," which is his proposed bridge letting the large-scale field body talk to the small-scale physical body — the link across scales the question asked about.

So the clean summary to hand your reader: the "real" and "p-adic" levels don't communicate like two correspondents — one is the physical world, the other is the mind's nested, simplified model of it, and they "touch" only at the clean rational points they share. *Communication proper* is a separate, physical affair: conscious selves on different sheets signaling each other by tuned light

— dark photons, cyclotron and Josephson resonances, the dark genetic code — with dark-to-ordinary photon conversion as the elevator connecting the big slow scales to the small fast ones.

Lighter caveat this time, since you've got the pattern: p-adic numbers and ultrametricity are genuine, respectable mathematics, and using "tree-like" number systems as a model of hierarchical cognition is an idea others have flirted with too. What's distinctively Pitkänen's — and unestablished — is that physical reality literally carries p-adic "cognitive shadow" sheets, and that the signaling machinery (dark photons, dark genetic code, biophoton bridging) is real. The defensible kernel is the map-versus-territory insight: that a mind relates to the world not by exchanging messages with a parallel realm but by building a simplified, well-structured internal model of it.

### **Q32 . What is the closest approximation to a “goal” in TGD – how does such directed, agentic behavior emerge and what is its effect on real and p-adic space?**

The question is really asking: in a universe made of mathematical shapes and quantum flickers, where does *purpose* come from — that sense a living thing has of aiming at something? Pitkänen builds his answer in two layers, a classical-physics layer that gives you goal-*directedness* almost for free, and a consciousness layer that turns it into a felt, chosen goal. It helps to take them in that order.

Start with the classical layer, because this is the elegant part. Recall from Q28 that a thing's whole life-history is a single fixed shape (a "Bohr orbit"), pinned down by its starting conditions. Here's the consequence Pitkänen draws out: if the *beginning* of the shape already determines the *end*, then the system behaves *as if* it were aiming at that end-state — the endpoint is built into the shape from the start. So directed, goal-seeking behavior isn't something you have to add on top of physics; it falls out of the geometry automatically. He uses the word *teleonomy* for this, a term borrowed from biology meaning "apparent purposefulness" — the way a growing acorn behaves as though it's *trying* to become an oak, even though no one thinks the acorn has intentions. A salmon swimming upstream, a wound healing toward intact skin, an embryo building toward a body plan: all of these look purposeful, and in Pitkänen's framing that look is real and grounded, because the target is encoded in the allowed shape itself. So the *closest approximation to a goal* in TGD is: the end-state that a life-history shape is mathematically headed toward.

But a fixed destiny would make goals rigid — and real agents change their minds. This is where the "tiny leak of indeterminacy" from earlier becomes essential. Because the rules fix the shape *almost* but not *completely*, there's never just one allowed future; there's a small *menu* of them. So at any moment the system isn't aimed at a single goal but has a *cluster of possible goals* available, and the wiggle room lets it shift from one to another. He layers his two kinds of quantum events onto this: the small, routine flickers (the ticks of consciousness) let the system

inch along *within* its current set of goals, growing its "window of awareness" as it goes; the big, dramatic events — the ones he links to sleep and death — actually *rewrite the starting data*, and therefore swap out the whole menu of available goals for a new one. The plain-language version: small adjustments let you pursue your current aim; a big reset lets you adopt fundamentally new aims. That combination — a built-in target plus the freedom to revise it — is what he thinks separates genuine intelligent goal-seeking from a thermostat blindly chasing a setpoint.

Now the consciousness layer, where a goal becomes something *felt and chosen* rather than just geometrically implied. This is the most interesting and most speculative part of his answer, and it rests on two moves. The first is that a goal has to be informed by the *outside world* — you can't sensibly aim at anything without some model of your environment — and he says those big resetting events are exactly where the system trades information with its surroundings and updates what it's aiming for. The second move is his account of *imagination*, and it's genuinely clever: he proposes that a system can run a *simulation* of a possible action inside the "non-frozen," undetermined part of itself — essentially daydreaming a course of action without committing to it. Crucially, he says these imagined runs come with *emotional coloring*: the simulation produces a feeling of the outcome being desirable or undesirable. So the agent picks its goal the way we often do — by imagining several futures, noticing which ones *feel* good or bad, and steering toward the good-feeling one. He even ties this to memory: revisiting a stored memory lets you re-feel the emotion attached to it, which helps you judge an imagined plan — and he notes a poignant cost, that the act of recalling a memory slightly *alters* it (a real, well-documented feature of human memory), which in his theory is the price you pay for being able to imagine emotionally.

He pushes this one striking step further at the biological level, which is worth handing your reader because it shows how literally he means all this. He suggests that the "dark genome" — his proposed shadow version of DNA living on the field body — might be the thing actually *running these simulations*, daydreaming possible courses of action in its undetermined degrees of freedom, with the survival of the simulating system as the implicit criterion for a "good" outcome. So in his picture, even something as basic as a cell or a gene could be quietly modeling possible futures and selecting among them. Whether or not one buys it, it's a vivid illustration of his core conviction that purpose and imagination go all the way down, not just up in brains like ours.

Finally, the last clause of the question — the effect on "real and p-adic space." Tying back to Q31: pursuing a goal isn't a message sent into a parallel realm. It plays out as the *physical* unfolding of the life-history shape (the "real" side), guided and represented by the system's internal, simplified model of the situation (the "p-adic," cognitive side). A goal, in other words, lives at the meeting point of the two: the imagined-and-emotionally-evaluated plan is built in the cognitive representation, and its pursuit is the physical shape actually taking that path. The "effect on real and p-adic space" is just this: a chosen goal is the cognitive side selecting which of the available physical futures the real side will realize.

So the clean summary you can give: the closest thing to a goal in TGD is the end-state baked into a system's life-history shape — purpose as geometry. The leftover indeterminacy turns that single destiny into a revisable *menu* of possible aims, and consciousness chooses among them by *imagining* the options and feeling which ones are desirable. Directed behavior thus emerges at two levels at once: automatically, from the shape (teleonomy), and deliberately, from emotion-guided simulation (intention).

Caveat for your reader, kept brief: "teleonomy" — apparent purposefulness without a literal planner — is a legitimate and widely used concept in mainstream biology, and the idea that brains choose by simulating and emotionally evaluating options is consistent with respectable cognitive science. What's Pitkänen's own and unestablished is the machinery underneath: indeterminacy as the seat of free choice, and especially the claim that DNA or single cells literally run emotion-tagged simulations of their futures. The solid kernel is "purpose can be real without a homunculus, and choosing is imagining-plus-feeling"; the speculative leap is *where* he locates that machinery and how far down he extends it.

### **Q33. What are Selves in TGD, are they able to coalesce and what is the driving force of this process?**

**Claude responded:** This question gets at the heart of his theory of mind — *what is a "self," really?* — and then asks something that sounds almost mystical, whether selves can merge into bigger selves. His answers are surprisingly concrete, and they tie together threads from all the earlier questions, so this is a good consolidating one.

Start with what a self *is*, because it's the foundation. Pitkänen's definition is deliberately minimal and a little startling: a self is *a sequence of quantum moments*. Recall those small "flickers" from the Q28 and Q32 answers — the routine quantum events he treats as the atoms of experience. A self is simply a *run* of them, one after another, all of the same kind. He builds this directly on top of a famous puzzle in ordinary quantum mechanics. Normally, if you keep measuring the same thing over and over, the system gets "frozen" by the repeated looking — physicists call this the Zeno effect (after the paradox of the arrow that, observed at every instant, never seems to move). Pitkänen takes that freezing and reinterprets it as the *continuity of a self*: one side of the system stays fixed and unchanged (that's the stable "you" that persists from moment to moment), while the other side updates with each flicker (that's your changing stream of experience). So a self is not a thing or a substance — it's a *process*, a steady patter of quantum events with a fixed anchor on one end and a moving edge on the other. Your felt sense of being a continuous person, and your sense of time flowing, are both just this patter, viewed from the inside.

A crucial feature he stresses is that selves are *nested* — there are selves inside selves, at every scale. This is the fractality idea from Q30 applied to minds. You are a self; but the proposal is

that your individual brain regions, your neurons, even your cells are *subelves* with their own dimmer streams of experience, and that you in turn are a subself of something larger (a social mind, ultimately a planetary one). He calls these your "subelves," and identifies them in everyday terms with things like your individual *mental images* — a single vivid thought or perception is, in his framing, a little self living and dying inside the larger self that is you. So the architecture of mind is a hierarchy of these ticking processes, each one both a whole (to its parts) and a part (of a greater whole).

Now the coalescing — *can selves merge?* — which is the striking middle of the question. His answer is an unqualified yes, and the mechanism is *quantum entanglement*. Entanglement is a real and well-established phenomenon: two quantum systems can become linked so that they can no longer be fully described separately — they behave as one combined system. Pitkänen's move is to say that *this is what merging minds physically is*. When two selves become entangled, they stop being two and a single larger self emerges in their place. And — this is the part worth dwelling on — the smaller selves *lose their separate consciousness* in the process. They don't sit side by side inside the bigger mind chatting; they dissolve into it, and a new unified experience takes over. He gives a concrete, almost reassuring example: the two hemispheres of your brain are arguably two selves whose field bodies *fuse* into the single unified experience you have right now. So merging isn't exotic — by his lights it's happening inside your own skull continuously.

He gives this a vivid physical picture, which is worth handing your reader because it makes the abstract idea graspable. He imagines the life-history shapes as having *tentacles* — he calls them "monopole flux tubes" — that can reach out and reconnect with another shape's tentacles. When two shapes link up this way, they form a stable bound pair, and that physical connection *is* the entanglement that fuses two selves into one. Pull the tentacles apart (a "reconnection" the other way) and the single self splits back into two. So the merging and splitting of minds, in his theory, is literally the joining and severing of these field-line tendrils between systems — the same mechanism, he claims, behind things as different as biological catalysis and the "memory of water." The image to leave your reader with: selves merge the way two soap bubbles merge into one when their walls touch and join, and split the way one bubble pinches into two.

Then the last part — *what is the driving force?* Why would selves merge at all, rather than just staying separate? His answer reaches back to the evolutionary arrow from Q28 and Q29. The pressure toward increasing complexity — his Negentropy Maximization Principle — *favours the formation of entanglement*, because an entangled, merged system is more complex and information-rich than its separate parts. So the driving force isn't a desire or a decision; it's the same mathematical current that drives evolution generally. Minds tend to coalesce into larger minds for the same reason matter tends to organize into life: because the universe, in his framing, is under a built-in pressure toward richer, more integrated structure. Merging is one of the main *ways* that complexity ratchets upward.

So the clean summary you can give: a self in TGD is a *process*, not a thing — a continuous run of quantum experiential moments with a stable anchor and a changing edge — and these processes are nested inside one another at every scale. Selves merge by becoming quantum-entangled (pictured as field-line tentacles reconnecting), and when they do, the smaller selves dissolve into a single larger one. The force pushing them to merge is the universe's general drive toward greater complexity and integration — the same arrow that powers evolution.

Caveat for your reader, brief: entanglement is real, established physics, and the broad idea that consciousness involves *integration* of information is taken seriously in mainstream theories of mind (Tononi's Integrated Information Theory, which appears in your reference list, is built on exactly that intuition). What's distinctively Pitkänen's and unestablished is identifying entanglement *as* the merging of literal subjective selves, the "flux tube tentacle" mechanism, and the claim that your neurons and cells are dimly conscious subselves. The defensible kernel is "the self is more like a process than a substance, and minds may integrate and divide"; the speculative leap is the specific physical machinery and how literally he extends consciousness up and down the scale ladder.

### **Q34 How does TGD architecture apply to evolution and morphogenesis, and to societies of minds?**

**Claude responded:** Synthesized theoretical frameworks to clarify evolution and collective intelligence

This is a consolidating question — it asks him to take the machinery built up across all the earlier answers and show it doing three jobs at once: making *shapes* (morphogenesis), making *complexity grow over time* (evolution), and making *group minds* (societies of minds). His answer is comparatively short because, by this point, he's mostly assembling parts you've already met. So I'll keep it organized around those three jobs and show which earlier building block each one reuses.

Take morphogenesis first — the making of forms and shapes, like an embryo growing into a body. Here Pitkänen makes a point that's easy to miss but is actually his proudest structural claim: in ordinary particle physics, a particle is a *point*, and a point has no shape, no size, no form at all. So mainstream physics has, at its foundation, *no notion of form* — form has to be explained as something that emerges later, out of formless dots. Pitkänen's whole starting move (from Q28) was to replace the point with a *surface*, a little 3-dimensional shape whose history is a 4-dimensional shape. The payoff he cashes in here: because his fundamental objects are *already shapes*, form isn't a late-arriving puzzle — it's there from the very bottom.

Morphogenesis, the generation of biological form, is then just a special, large-scale case of the same shape-making that governs particles. He adds that his "field-line tentacles" (the monopole flux tubes from Q33) are the building blocks of the controlling field bodies that steer this form-

making. So the headline is: *TGD has form built into its floor, so growing a body is continuous with the geometry of physics itself, not a separate mystery.*

Now evolution, where he leans on the number-theory side and the complexity arrow. The picture is the one from Q28 and Q29: life-history shapes can be *stacked* (his "functional composition"), and stacking automatically produces shapes of exponentially greater complexity, with no upper limit. Evolution, for him, is simply this ladder being climbed — not Darwin's random mutation filtered by survival, but a built-in mathematical pressure toward richer structure. The fresh wrinkle he introduces in *this* answer is a bold reinterpretation of two cornerstones of mainstream math: he proposes that his shapes don't just *resemble* numbers, they *are* numbers, in a very general sense — geometry and arithmetic become two languages for the same objects (his "Langlands duality," named after a deep and genuinely real area of mathematics, stretched here to four dimensions). And he reaches for *Galois theory* — the classical mathematics of how the solutions to an equation can be shuffled among themselves — and suggests that the "shuffling groups" which mathematicians use to classify equations have a physical counterpart: as a system evolves and grows more complex, it climbs a tower of these ever-richer shuffling structures. The plain-language takeaway, setting the machinery aside: *evolution in TGD is the universe doing more and more elaborate mathematics, and the growth of biological complexity is the visible face of that.* He caps this with the line that recurs throughout — that this is how "mathematics becomes conscious of itself," since (from Q29) the lifeless space of forms becomes aware through the quantum moments that visit it.

He folds one more idea into the evolution section that's worth surfacing for your reader, because it connects to today's AI debates: the distinction between a *concept* and its *instances*. He notes that today's machine-learning systems only ever see *instances* — millions of examples of cats — and never grasp the *concept* "cat" itself. His theory, he claims, can represent a genuine concept physically: not as a pile of examples, but as a single quantum object that holds all the examples in *superposition* at once (a "quantum concept"). And a single ordinary concept, he adds, corresponds to *many* quantum concepts — different perspectives on it depending on which questions you ask. Whether or not the physics holds up, it's a clean statement of a real philosophical gap in current AI, and it shows he's thinking about evolution as the growth of genuine *understanding*, not just accumulated data.

Finally, societies of minds — and here the answer is short because it's almost entirely a re-application of Q33. A "society of minds" is just a *self-hierarchy*: selves nested inside larger selves, with more complex levels controlling simpler ones (the master-slave hierarchy from Q30). The prerequisite for such a society is the ladder of increasingly complex shapes — you need rungs for the higher selves to occupy. And the *mechanism* by which a society forms is exactly the merging mechanism from Q33: the field-line tentacles reconnect, two selves become entangled and fuse into a larger one, and that larger self is a "society" relative to its members; sever the connections (in a quantum event) and the society dissolves back into individuals. So a society of minds isn't a metaphor in his framework — it's a literal larger self, built by the same

tentacle-reconnection that fuses your brain hemispheres into a single experience, just operating at a bigger scale and across more individuals.

So the clean summary you can give: TGD treats *form-making, evolution, and group minds as one phenomenon at three scales*. Form is built into the foundations because the fundamental objects are shapes, not points — so growing a body is continuous with the geometry of particles.

Evolution is the climbing of an open-ended ladder of mathematical complexity — the universe performing ever-richer arithmetic, which is what makes it progressively more conscious of itself. And societies of minds are simply selves merging into larger selves by entanglement, the same nesting-and-fusing seen everywhere else, scaled up. The unifying thread, as always, is the fractal hierarchy: the same generative move repeating from particles to embryos to civilizations.

Caveat for your reader, brief: the *questions* he's engaging are serious and mainstream — how form arises (a real open problem in developmental biology), whether evolution has any inherent direction (genuinely debated), and the gap between pattern-matching and true concepts in AI (a live, sharp critique, echoed by people like Gary Marcus in your reference list). What's Pitkänen's own and unestablished is the specific apparatus: shapes-as-numbers, Galois towers as the engine of biological evolution, and entanglement as the literal fabric of societies of minds. The defensible kernel is "form, complexity-growth, and collective intelligence may all be expressions of one underlying principle"; the speculative leap is the particular mathematical and physical machinery he says that principle is.