The Human as Electromagnetic Being: A Quaternion Biofield Model Integrating Bioelectricity, Personality Dynamics, and Energetic Structure

J. Konstapel, Leiden, 11-3-2026.

With the help of claude.

Abstract

This paper proposes a comprehensive framework in which the human being is understood as a fundamentally electromagnetic system. Drawing on Michael Levin's empirical work on bioelectricity, James Clerk Maxwell's original quaternion formalism, William Rowan Hamilton's quaternion algebra, and Harry Stack Sullivan's interpersonal theory, a unified model is constructed in which personality, cognition, and relational dynamics are represented as structured electromagnetic phenomena. The Myers–Briggs Type Indicator (MBTI) serves as a psychometric entry point, its four dimensions mapped onto quaternion components operating on a continuous polarity scale of $[-1, 0, +1]$. The resulting model produces spiral (helical) trajectories through four-dimensional space, exhibiting nilpotent convergence toward a scalar equilibrium. The framework bridges cellular bioelectricity, field physics, and personality psychology, offering a mathematically grounded, empirically motivated account of the human being as a dynamic, self-organizing bioelectric field.

Keywords: bioelectricity, quaternion, biofield, MBTI, personality dynamics, electromagnetic, Michael Levin, Maxwell, interpersonal theory, spiral dynamics, nilpotent algebra

1. Introduction

For much of the twentieth century, the dominant paradigm in biology treated the human organism as a primarily biochemical system — a complex arrangement of molecules governed by genetic instruction. Personality and cognition were studied through psychometric abstraction, largely disconnected from the physical substrate of the body. Energy, fields, and electromagnetic phenomena were considered secondary at best, epiphenomenal at worst.

This paper argues that such fragmentation is no longer tenable. Converging lines of evidence — from developmental biology, physics, and psychology — point toward a unified picture: the human being is at its core an electromagnetic system, and personality, cognition, and interpersonal behavior are structured expressions of that system's dynamic field properties.

The argument is built in four stages. First, we review Michael Levin's experimental evidence that bioelectric signals constitute a primary information system governing biological form, behavior, and cognition at every scale from the single cell to the whole organism. Second, we revisit Maxwell's original quaternion formalism as the appropriate mathematical language for describing field

dynamics, noting that the subsequent Heaviside–Gibbs reformulation into modern vector calculus discarded critical structural information. Third, we map the four dimensions of the Myers–Briggs Type Indicator onto quaternion components, constructing a dynamic model of personality as a rotating, spiraling trajectory in four-dimensional quaternion space. Fourth, we connect this framework to Sullivan's interpersonal theory, showing that the quaternion biofield model naturally generates a three-dimensional interpersonal circumplex, unifying psychological and physical perspectives.

The result is not merely an analogy or metaphor. The same algebraic structure that Maxwell used to describe electromagnetic fields is applied here to describe the human biofield — with the claim that this structural identity reflects a physical reality: the human being is an electromagnetic being.

2. Bioelectricity as Primary Information System: The Evidence of Michael Levin

2.1 Beyond the Genomic Paradigm

The canonical model of biological development assigns primacy to the genome: DNA encodes proteins, proteins construct organisms, genetic mutations produce heritable changes in form and function. While this model has been extraordinarily productive, it is increasingly recognized as incomplete. The genome does not by itself specify the three-dimensional organization of a living body. Something else is required — something that orchestrates the collective behavior of billions of cells into coherent, goal-directed form.

Michael Levin, Distinguished Professor at Tufts University and director of the Allen Discovery Center, has spent more than two decades demonstrating that this organizing principle is bioelectricity. His research establishes that endogenous electric fields — generated by ion channels and gap junctions across all cell types, not merely neurons — constitute a primary signaling modality that controls large-scale patterning, morphogenesis, regeneration, and cancer suppression.

2.2 The Bioelectric Code

Levin's central finding is that cells form bioelectrical networks that store and process pattern information. These networks function as a kind of morphogenetic memory: they encode representations of large-scale anatomical structures — where organs will form, how the anterior–posterior axis will be oriented, what shape the organism will ultimately take. This information is held in the electrical state of cell networks across large tissues, in a manner directly analogous to how neural networks hold memories.

Critically, this bioelectric information layer is distinct from, and not reducible to, the genetic layer. Levin's team has demonstrated that permanent anatomical changes can be induced in organisms by brief bioelectric interventions — without any alteration of the genome. Planarian flatworms, for example, can be made to regenerate with two heads or two tails by transiently modifying voltage patterns via ion channel drugs. Once established, this new bioelectric pattern is self-maintaining: subsequent generations of the worm continue to express the altered anatomy without further intervention.

2.3 Scale-Free Cognition and the Computational Self

Levin's framework extends beyond morphogenesis into cognition. He argues that bioelectric networks exhibit a form of basal cognition — the capacity for memory, learning, and goal-directed problem-solving — not only in neural tissue but in all somatic cells. The boundary of the "self," in Levin's model, is defined by the reach of bioelectric coherence: cells that share electrical state information constitute a cognitive unit.

This principle operates across scales. Individual cells are cognitive agents. Organs are higher-order cognitive units. The whole organism represents a further integration of these nested bioelectric fields. The implication is radical: cognition, in the most general sense, is a property of organized bioelectric systems, not exclusively of brains.

2.4 Three Determinants of Form

Levin identifies three primary forces that determine biological form: genomic, bioelectric, and biomechanical. Of these, the bioelectric layer occupies a middle position — it integrates genetic information and mechanical constraints into coherent spatial patterns. It is, in effect, the field that translates genetic potential into living form.

For the present argument, Levin's work establishes the following foundational claims:

- The human organism is pervasively bioelectric at every scale.
- Bioelectric fields carry structured information governing form, behavior, and cognition.
- This information is organized in coherent, dynamic patterns that can be read, written, and modified.
- The boundary of the self is defined by the extent of bioelectric coherence.

These claims provide the empirical foundation for the model developed in subsequent sections.

3. Maxwell's Quaternion Formalism and the Structure of Fields

3.1 The Original Formalism

James Clerk Maxwell's equations of electromagnetism, as originally formulated in his 1873 *Treatise on Electricity and Magnetism*, were not written in the vector calculus familiar to modern physicists. Maxwell used the quaternion algebra developed by William Rowan Hamilton, which he considered the natural mathematical language for describing field phenomena.

Hamilton introduced quaternions in 1843 as a four-dimensional extension of complex numbers. A quaternion takes the form:

$$\mathbf{q = a + bi + cj + dk}$$

where a is the scalar component, and $bi + cj + dk$ is the pure quaternion (or vector quaternion) component, with three mutually orthogonal imaginary axes i, j, k obeying the multiplication rules:

$$\mathbf{i^2 = j^2 = k^2 = ijk = -1}$$

Maxwell recognized that this structure was ideally suited to representing physical fields: the scalar component captured magnitude or potential, while the three imaginary components captured directional structure in three-dimensional space. Rotations and transformations of fields could be

expressed as quaternion multiplications — an operation that is both algebraically elegant and physically meaningful.

3.2 The Heaviside Reduction

In the decades following Maxwell's death, Oliver Heaviside and Josiah Willard Gibbs independently reformulated Maxwell's equations in terms of modern vector analysis. This reformulation discarded the scalar component of the quaternion and replaced the full quaternion algebra with three-component vectors and scalar fields treated as separate objects. The resulting formalism — the one taught in physics today — is computationally convenient but structurally impoverished.

What was lost in the Heaviside–Gibbs reformulation was the unified four-dimensional structure of the original quaternion field. The scalar and vector parts of the quaternion are not independent: they are aspects of a single four-dimensional object. Separating them destroys the algebraic coherence of the formalism and, crucially, obscures the rotational and transformational properties that quaternions naturally encode.

3.3 Quaternions as the Language of Field Dynamics

The present model returns to Maxwell's original insight. Quaternion algebra is the appropriate mathematical language for describing dynamic field systems precisely because it captures, in a single object, both the scalar state (magnitude, potential, equilibrium) and the three-dimensional directional structure (orientation, rotation, transformation) of a field.

For a field that is continuously rotating, transforming, and self-organizing — such as a bioelectric field — quaternion algebra is not merely convenient; it is structurally necessary. The rotational properties of quaternions, their capacity to represent continuous transformations in four-dimensional space, and their natural polarity structure (with values ranging between −1 and +1 on each axis) make them the ideal formalism for the model developed below.

4. The Quaternion Biofield Model of Personality

4.1 The MBTI as Psychometric Entry Point

The Myers–Briggs Type Indicator organizes personality along four dichotomous dimensions:

- **Extraversion–Introversion (E–I):** orientation of energy and attention
- **Sensing–Intuition (S–N):** mode of information perception
- **Thinking–Feeling (T–F):** mode of decision-making
- **Judging–Perceiving (J–P):** orientation toward structure and openness

Conventionally, these dimensions yield 16 discrete personality types. This discrete typology, however, is a simplification: empirical measurement consistently shows that individuals are distributed continuously along each dimension, not clustered at the poles.

The present model treats these four dimensions not as categorical types but as continuous variables, each representing a polarity within the interval $[-1, 0, +1]$, where 0 represents the neutral equilibrium point and ±1 represent the extreme poles.

4.2 Mapping MBTI onto Quaternion Components

The four MBTI dimensions are mapped onto quaternion components as follows:

q = a + bi + cj + dk

- **a (scalar component):** the central equilibrium state — the individual's homeostatic baseline, representing balance across all dimensions.
- **b (i-axis):** the S–N dimension — the mode of information perception, ranging from concrete sensing (−1) to abstract intuition (+1).
- **c (j-axis):** the T–F dimension — the mode of decision-making, ranging from analytical thinking (−1) to relational feeling (+1).
- **d (k-axis):** the J–P dimension — the structural orientation, ranging from structured judging (−1) to open perceiving (+1).
- **E–I:** governs the rotational orientation of the quaternion around its central axis — extraversion corresponding to clockwise (outward) rotation, introversion to counterclockwise (inward) rotation.

This mapping is not arbitrary. The S–N and T–F dimensions together define a cognitive-affective plane — the space of perception and evaluation — that corresponds naturally to the base plane of the quaternion. The J–P dimension adds vertical structure, modulating the degree of openness or closure in the system. The E–I dimension governs the rotational dynamics of the whole field — whether energy flows outward toward the environment or inward toward the self.

4.3 The Polarity Scale: −1 ≤ 0 ≤ 1

Each quaternion component is defined on the continuous interval [−1, +1] with 0 as the central balance point. This structure has several important properties:

- It avoids binary categorization, representing intermediate states naturally.
- It defines a symmetric polarity around a neutral center — mathematically equivalent to the structure of oscillating systems.
- The center (0) functions as an attractor state — the point of dynamic equilibrium toward which the system tends in the absence of perturbation.
- The poles (±1) represent maximum expression of a dimension — states of highest differentiation from the center.

This polarity structure maps directly onto the electromagnetic properties of the biofield. Ion channel voltages oscillate between resting potential and action potential. Membrane potentials fluctuate around equilibrium values. The [−1, 0, +1] interval is not merely a psychological convenience; it reflects the actual polarity structure of bioelectric cellular dynamics.

4.4 Spiral Trajectories and Helical Dynamics

When the quaternion components vary continuously and the E–I rotation is applied, the resulting trajectory through four-dimensional quaternion space is helical — a spiral. The combination of:

- rotation in the cognitive-affective plane (E–I),
- vertical movement along the structural axis (J–P),
- continuous variation in the perception-evaluation plane (S–N × T–F),

produces a three-dimensional helix: a spiraling path through the state space of the personality field.

This spiral structure is not merely geometrically elegant. It reflects a fundamental property of oscillatory systems: the combination of rotation and directed movement produces helical dynamics. In electromagnetic terms, this is precisely the structure of a propagating wave — the spiral of the electric and magnetic field vectors around the axis of propagation.

The 16 MBTI types, in this model, are not discrete points but regions along the spiral — characteristic attractors around which the trajectory tends to cluster, without being rigidly fixed.

4.5 Nilpotent Convergence and Homeostatic Stabilization

The model incorporates a nilpotent operator acting on the quaternion state space. In linear algebra, a nilpotent operator N satisfies $N^k = 0$ for some finite k: repeated application of the transformation eventually converges to zero.

Applied to the personality biofield, this means that iterative transformations — perturbations, experiences, interactions — ultimately converge toward the scalar center ($a = 0$ with all imaginary components vanishing). This models the homeostatic stabilization of the biofield: the tendency of the system to return to equilibrium after perturbation.

Importantly, nilpotent convergence does not imply that the system is static or that development is impossible. It means that the system has a finite developmental trajectory — a Jordan chain structure in algebraic terms — with a characteristic attractor at its center. The spiral does not expand indefinitely; it converges, models the arc of psychological development as a progressive approach toward integration and balance.

5. Interpersonal Dynamics and the Three-Dimensional Circumplex

5.1 Sullivan's Interpersonal Theory

Harry Stack Sullivan, in his foundational work on interpersonal psychiatry, argued that personality is not a property of isolated individuals but emerges exclusively in the field of interpersonal relations. The self, for Sullivan, is constituted through its interactions — it is inherently relational, defined by the patterns of its engagement with others.

This insight has a direct structural parallel in field physics. A field does not exist in isolation; it is defined by its interactions with other fields and with the charges or currents that generate it. The bioelectric field of an individual is not self-contained; it is continuously modified by, and modifies, the bioelectric fields of others in proximity.

5.2 The Quaternion Circumplex

The quaternion biofield model naturally generates an interpersonal circumplex. The cognitive-affective plane (S–N × T–F) defines a two-dimensional relational space — the space of perception and evaluation in which interpersonal behavior is organized. The E–I rotational axis modulates the orientation of energy in this space — outward toward others or inward toward the self. The J–P vertical axis adds a dimension of structural flexibility, governing whether the individual engages with others through fixed structures or open responsiveness.

The result is a three-dimensional interpersonal field in which:

- Position in the cognitive-affective plane represents characteristic relational style.
- Rotational orientation (E–I) represents the direction of interpersonal energy flow.
- Vertical position (J–P) represents structural flexibility in relational engagement.

This three-dimensional circumplex extends Sullivan's two-dimensional model into a full three-dimensional field structure, grounded in the same quaternion algebra that Maxwell used to describe electromagnetic fields.

5.3 Interpersonal Resonance

When two quaternion biofields interact, their rotational and structural properties determine the nature of the interaction. Fields with compatible rotational orientations (similar E–I profiles) tend toward resonance — mutual amplification of shared states. Fields with complementary structures (compatible S–N × T–F and J–P configurations) tend toward coherent integration. Fields with incompatible structures generate interference patterns — the experiential correlate of interpersonal conflict.

This resonance model of interpersonal dynamics is consistent with both Sullivan's clinical observations and Levin's bioelectric framework, in which gap junctions allow direct electrical communication between cells — the cellular equivalent of interpersonal resonance.

6. The Human as Electromagnetic Being: Synthesis

6.1 Structural Identity, Not Analogy

The central claim of this paper is that the quaternion biofield model of personality is not an analogy to electromagnetic field theory — it is an application of the same mathematical structure to the same physical phenomenon at a different scale.

Levin has demonstrated that the human organism, at every scale from the single cell to the whole body, is organized by bioelectric fields that carry structured information and govern form, behavior, and cognition. Maxwell demonstrated that electromagnetic fields are most naturally described by quaternion algebra. The present model applies that algebra to the human biofield, representing personality dynamics as structured transformations of a four-dimensional quaternion state.

The structural identity between the mathematics of electromagnetism and the mathematics of the personality biofield is not coincidental. It reflects the physical reality that personality — the characteristic pattern of an individual's cognitive, affective, and relational dynamics — is an expression of the organized electromagnetic field of the living body.

6.2 Multi-Scale Integration

The model integrates across multiple scales:

- **Cellular scale:** ion channels and gap junctions generate the membrane voltage patterns that Levin has shown to carry morphogenetic and cognitive information.
- **Tissue and organ scale:** coherent bioelectric networks across tissues generate the body-wide bioelectric field.
- **Whole-organism scale:** the integrated bioelectric field of the organism constitutes the quaternion biofield modeled here.
- **Interpersonal scale:** interactions between individuals are interactions between quaternion biofields — governed by resonance, interference, and coherence.

6.3 Dynamic Self-Organization

The spiral trajectory of the quaternion biofield reflects the fundamental property of living systems: dynamic self-organization. The system is never static; it is continuously rotating, transforming, and adapting. The nilpotent convergence toward the scalar center models the homeostatic tendency — the return to equilibrium — that characterizes healthy biological systems.

Levin's observation that bioelectric patterns degrade with aging corresponds, in the quaternion model, to a loss of rotational coherence — a flattening of the spiral toward the center without the dynamic rotation that characterizes healthy function. Interventions that restore bioelectric coherence would, in quaternion terms, restore the rotational and helical dynamics of the field.

7. Discussion

7.1 Implications for Personality Research

The quaternion biofield model has several implications for the study of personality. First, it reframes personality not as a static typology but as a dynamic trajectory — a path through four-dimensional state space that is characteristic of an individual but continuously evolving. Second, it connects personality to its physical substrate — the bioelectric field of the body — providing a basis for empirical investigation of the relationship between bioelectric dynamics and psychological characteristics. Third, it provides a mathematical framework for modeling personality change, development, and therapeutic intervention as transformations of the quaternion state.

7.2 Implications for Biofield Research

For biofield research, the model offers a specific mathematical structure — quaternion algebra — as the appropriate formalism for describing the human biofield. This is a more precise proposal than the general invocation of "energy fields" that characterizes much biofield literature. The quaternion structure makes specific predictions: the biofield has four components (one scalar, three imaginary); it exhibits rotational dynamics; its polarities range continuously between −1 and +1; and its transformations follow quaternion multiplication rules.

7.3 Implications for Interpersonal Dynamics

The resonance model of interpersonal dynamics, derived from the quaternion structure, provides a physically grounded account of phenomena that Sullivan described clinically: the tendency of individuals to elicit characteristic responses in others, the organization of relationships around complementary or resonant field structures, and the therapeutic significance of field coherence in the therapeutic relationship.

7.4 Limitations and Future Directions

The present model is theoretical and requires empirical development. The primary challenge is operationalization: how are the quaternion components of the human biofield to be measured? Levin's tools for reading and writing bioelectric state information in somatic tissues suggest one pathway — direct measurement of the body's bioelectric field, mapped onto the quaternion dimensions proposed here. The MBTI dimensions provide a psychometric proxy, but a direct bioelectric measurement would provide a more rigorous test of the model's claims.

Future work should:

1. Develop protocols for measuring quaternion biofield components from bioelectric data.
2. Test the predicted correspondence between MBTI profiles and bioelectric field patterns.
3. Model interpersonal resonance and interference using quaternion field interactions.
4. Investigate the relationship between bioelectric coherence, spiral dynamics, and psychological health.
5. Explore therapeutic applications of bioelectric field modulation within the quaternion framework.

8. Conclusion

This paper has argued that the human being is fundamentally an electromagnetic being, and that this physical reality is expressed at the level of personality and interpersonal dynamics through the structured dynamics of the quaternion biofield.

The argument rests on four pillars. Levin's empirical work establishes that bioelectric fields are the primary information system governing biological form, behavior, and cognition. Maxwell's quaternion formalism provides the natural mathematical language for describing field dynamics. The mapping of MBTI dimensions onto quaternion components constructs a dynamic model of personality as a spiraling trajectory in four-dimensional space. And Sullivan's interpersonal theory finds its physical grounding in the resonance dynamics of interacting quaternion biofields.

The model is not a metaphor. It is a proposal that the same mathematical structure — quaternion algebra — that Maxwell used to describe the electromagnetic field describes, at a larger scale, the human biofield that Levin has empirically characterized. The human being is not merely influenced by electromagnetic phenomena; the human being is, at its organizing core, an electromagnetic being — a dynamic, self-organizing, spiraling quaternion field.

References

Hamilton, W. R. (1843). On quaternions; or on a new system of imaginaries in algebra. *Philosophical Magazine*, 25, 489–495.

Levin, M. (2007). Large-scale biophysics: ion flows and regeneration. *Trends in Cell Biology*, 17(6), 261–270.

Levin, M. (2014). Molecular bioelectricity: how endogenous voltage potentials control cell behavior and instruct pattern regulation in vivo. *Molecular Biology of the Cell*, 25(24), 3835–3850.

Levin, M. (2019). The computational boundary of a "self": developmental bioelectricity drives multicellularity and scale-free cognition. *Frontiers in Psychology*, 10, 2688.

Levin, M., Selberg, J., & Rolandi, M. (2019). Endogenous bioelectrics in development, cancer, and regeneration: drugs and bioelectronic devices as electroceuticals for regenerative medicine. *iScience*, 22, 519–533.

Manicka, S., & Levin, M. (2019). Modeling somatic computation with non-neural bioelectric networks. *Scientific Reports*, 9, 18612.

Maxwell, J. C. (1873). *A Treatise on Electricity and Magnetism*. Clarendon Press.

Myers, I. B., & Briggs, K. C. (1962). *Myers–Briggs Type Indicator*. Educational Testing Service.

Sullivan, H. S. (1953). *The Interpersonal Theory of Psychiatry*. Norton.

Pio-Lopez, L., & Levin, M. (2024). Aging as a loss of morphostatic information: a developmental bioelectricity perspective. *Ageing Research Reviews*, 97, 102310.

Durant, F., Bischof, J., Fields, C., Morokuma, J., LaPalme, J., Hoi, A., & Levin, M. (2019). The role of early bioelectric signals in the regeneration of planarian anterior/posterior polarity. *Biophysical Journal*, 116(5), 948–961.