Entropy, Relation, and the Signature of God

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I. Overture: Hearing the Author

A few notes can disclose the signature of their composer: a dark bar, a rising line, a sudden hush, and the *Lacrimosa* reveals Mozart without need of a program. We recognize style: intervals and cadences, voice-leading and suspensions. This is tacit knowing in the sense that physical chemist Michael Polanyi meant it. We attend from subsidiary clues to a focal pattern, and by indwelling those clues we grasp a coherence that exceeds the sum of its parts. This is not inference from neutral data, but a form of knowing that precedes explicit articulation. As Polanyi famously observed, "We can know more than we can tell."[1]

Tacit knowing, however, should not be confused with presupposition in a strict sense. Tacit knowing names how understanding is achieved, through the skilled integration of clues into a meaningful whole. Presuppositions, by contrast, name the fiduciary commitments that condition inquiry by guiding attention and expectation. Presuppositions are not conclusions reached at the end of argument; they are conditions under which inquiry becomes possible at all. One does not pause to prove them; one lives from them, and they make recognition possible. Presuppositions shape the field of inquiry; tacit knowing is how inquiry succeeds within it.

The claim advanced here is neither triumphalist nor naïve. We do not claim that it is possible to deduce Trinitarian dogma from the natural sciences. Rather, when one attends closely to the forms by which the world coheres, to the minimal structures of relation that make order intelligible, one may discern style, a signature of triune authorship. The Christian confession that God is one in three Persons is not demonstrable by laboratory result. Instead, we argue that if we begin with the presupposition of the Triune God as the ontological ground, then creation's forms may be read analogically as vestigial, that is, as traces whose structure bears the recognizable signature of their Author. This mode of reading creation belongs to what St. Bonaventure described as the discernment of *vestigia Dei*, traces of the Creator within creation that do not collapse Creator and creation, yet nonetheless disclose the form of divine authorship.[2]

Two concepts will occupy us in what follows. The first is the use of the term *τροπή* by St. James, the author of the New Testament epistle bearing his name, to articulate the unchangeability of the Triune God in James

1:17. The second arises from quantum theory. In Relational Quantum Mechanics (RQM), the minimal closure of a web of relations is not one, not two, but three: the smallest system capable of witnessing its own relations. Carlo Rovelli has called this the "dance for three."[3] We will argue that the analogical resonance between these domains, between immutability and relation and between entropy and closure, functions as an authorial signature, not a proof, but a recognition. What follows is a synthesis of exegetical theology, statistical mechanics, and quantum foundations, offered in the spirit of the liberal arts. Like an overture, this opening establishes the motifs that will be developed at length, and with greater precision, as the argument unfolds.

II. The Etymology of Change

We register time by noticing change; the clock on the wall merely records it. In science, the term "entropy" names change with precision. Prussian scientist Rudolf Clausius coined the word in the nineteenth century by tapping an older, nuanced idea: the Greek τροπή (from τρέπω), a word family that speaks of "turning." The verb denotes setting a course or turning toward an action; the noun names the dynamic movement of a process.[4] The changes τροπή can describe vary drastically. We encounter the word in Homer's Iliad where it is used to describe military withdrawal: the dynamic transformation from offense to retreat.[5] Plato used the term when discussing the variation in stars and planets. In the Wisdom of Solomon, τροπή describes the changing of the seasons.[6] Josephus used the word to refer to changes in countenance caused by altered health or emotion.[7] The common notion in all these uses is the process of change, that is, *transformation*.

Τροπή continued its long and diverse history when an insightful Clausius chose it to term his newly discovered law of thermodynamics. In his 1865 paper titled "On Various Convenient Forms for the Fundamental Equations of the Mechanical Theory of Heat," Clausius wrote, "I propose to name the magnitude *S* the *entropy* of the body, from the Greek word ἡ τροπή, transformation."[8] As we have seen, τροπή is a word uniquely capable of describing transformation in any number of contexts. Here we see Clausius's brilliance. In selecting τροπή to coin the term "entropy," he found a word uniquely suited to demarcate the *process* of transformation in various situations.

His selection of this word was informed by a lifetime of classical education. His father, Rev. Christian M. Clausius, was a Protestant minister in Köslin and provided Clausius and his siblings with the majority of their early education.[9] He continued his education at a gymnasium in Stettin, followed by a time at Boeckh's Royal Seminary at the University of Berlin pursuing history before transferring to the physics department.[10] Given these long years of classical education prior to submitting his dissertation at the University of Halle, his understanding of Greek and Latin would have been masterful. By all accounts, Clausius was in his own right an informed and ingenious contributor to the history of τροπή's use and interpretation.

Clausius had learned to weigh words, to hear a term's connotations across science, rhetoric, and theology, and to stabilize a technical meaning without severing it from its historic meaning. τροπή's unique ability to demarcate such a wide panoply of variation was perfect for his newly articulated theory of thermodynamics. Clausius's own definition of entropy was in fact, "the transformational content of the body."[11] Notice both the precision of the phrase "transformational content" and the range of the term "body." In crafting the word entropy, Clausius concretized the heart of his discovery, identifying transformation as the central and universal concept in his theory of thermodynamics.

These two features matter because they show that Clausius's appeal to τροπή was not decorative classicism, but a disciplined act of naming. His training led him to pick a Greek term that already signified turning-as-process and then to fix its sense in a technical context ("transformational content"). That discipline is the point of contact with James 1:17. We are not arguing from a mere lexical overlap. Rather, the same semantic family (*τρέπω*/τροπή) is used carefully in two registers, specifically thermodynamics and theology, each time with context-limited meaning. Clausius's formation therefore models the very hermeneutic we adopt with James: avoid the etymological fallacy, specify the sense, and let τροπή name transformation in precisely the way the context allows. On that basis, the analogy we draw later is method-driven, not word-driven.

III. No Variation or Shadow Due to Change: James's Doctrine of Immutability

Why set Clausius beside James? Because they speak about change from complementary directions. Clausius names and measures transformation within creation; James names the Unchanging One in whom creation's transformations "live and move." "Every generous act of giving, with every perfect gift, is from above, coming down from the Father of lights, with whom there is no variation or shadow due to change" (Jas 1:17). Here James speaks of change by denying it of God: divine immutability is the ground on which created variation occurs. The register is theological and cosmological. The title "Father of lights" evokes the creative act (Gen 1:3), and the next verse (1:18) speaks of new birth (ἀποκυέω) and creatureliness (κτίσμα). In short, the regularity of creation's turnings presupposes the unturning God.[12] Read this way, τροπή retains disciplined meaning in both contexts: in thermodynamics, the quantified transformation of systems; in James, the cosmological "turnings" over against divine immutability.

However, James introduces this impassible, unchanging God not only to communicate dogma, but as the ground for later pastoral instruction. James 1:17 becomes essential for the rest of James's letter. God's invariable nature is the foundation for the Church's movement as it seeks to image its creator. James will entreat his audience to avoid the sin of double-mindedness and act analogously to their unchangeable God (Jas 1:8; 4:8). He conjoins his reader to call upon and emulate the wisdom that comes

from above, one of the good and perfect gifts which comes down from their unchangeable God (Jas 3:17, 17). He calls them to steadfastness in trial, knowing that those who do not change allegiances under duress will receive the crown of life (Jas 1:12; 5:11). The unchangeability of God has direct consequences for how believers relate to one another. In human life, relationships often fracture under pressure or shift with circumstances; James calls his audience to avoid such "double mindedness" by imitating the steadfastness of their unchanging God. The triune God, whose three persons live in perichoretic unity, provides the stable pattern for the church's own unity and fidelity. Paradoxically, it is God's immutability that gives creatures the secure ground on which genuine transformation and enduring relationships are possible.

God's unchangeability is itself transformational. In James 1:18, the unchangeable God who created all things is identified as the cause of re-creation. The transformation that happens in believers at regeneration, this re-creation, is brought about by the unchangeable God. Therefore, the God who is one, who cannot undergo any change, is alone the one who can create all things out of nothing, and it is this same God who can recreate the fallen creation. "This new birth is motivated by the sovereign determination of God, whose *will*, unlike the creation he made, is unvarying."[13] Only the uncreated God who does not vary can cause the necessary variation to create and recreate the cosmos. As Aquinas says, nothing itself created can create "either by its own power or instrumentally."[14]

Connecting the oneness of God to his creative power is not novel to James's text. Second-Temple Jewish liturgies would place the Shema immediately after a series of benedictions, including the Yotzer Or in which God was praised for creating light and renewing the works of creation.[15] Only then is the Shema confessed: "Hear, O Israel… the LORD *is one*" (Deut 6:4). Hence, James continues the tradition of the Hebrew Scriptures and the intertestamental period by linking God's immutable oneness to his creative power. In other words, God is not sterile in his unchangeability, but fecund. God's immutable nature allows for his creative activity and enables the movement and relations of his creatures. We will expand on this concept in Section V, but in preparation, we must first describe the ground of all creation.

IV. The First Closed Structure in the Cosmos

In James, τροπή marks the contrast between the constancy of God and the turnings of creation. This distinction is crucial: only God's immutability can sustain the flux of creaturely life. To see how the created order itself bears a complementary signature, we shift from theology to physics. Relational quantum mechanics (RQM), with its emphasis on interaction rather than isolated substance, discloses a parallel truth: the minimal closure of relation requires three. Quantum mechanics refines an older picture of reality as a universe of classical particles, each with its intrinsic properties. The relational interpretation, originating with Carlo Rovelli, argues that

properties are not intrinsic; they are relative to interactions. A quantum event is always for some system. Without interaction, an isolated particle is irrelevant, not because it doesn't exist, but because quantum properties are relational.[16] This can be misinterpreted as a mystical concept, but it is nothing of the kind. The theory says that when particle A interacts with particle B, a correlation is established (e.g., "spin up relative to B"). In the classic RQM picture, such a statement is always for some system: the relation A–B is for A (or for B). A natural question then arises: how, if at all, can A's account of B be made comparable with B's account of A without leaving the relational framework? We are not seeking a God's-eye view, as it were; we are asking about public comparability, the possibility of bringing relational reports into a shared, checkable record. Here is where the "dance for three" earns its name. Two are insufficient for closure. They correlate, but their reports remain pair-relative unless a third system C interacts so as to carry a physical record that links the two descriptions. Three is the smallest number that lets a relation "stand on its own" in this operational sense. With only two, whatever happens remains a private exchange; add a third, and each pair can be seen against a common record.[17] If it helps, think of a three-legged stool: two legs wobble until the third makes it stand. Or picture a triangle: a line between two points never encloses anything; add a third point and the shape closes. However you see it—witness, stool, or triangle—the lesson is the same: the third gives the system stability and a perspective that the pair cannot supply, which is why three is the first arrangement that can be shared as common ground.

Rovelli's colloquial phrase, entanglement as a "dance for three", is more than flourish; it captures a formal threshold.[18] One system is trivial; two form a line; three is the first closure. The fact, in RQM, is that reality shows up as relation, and the minimal unit that can sustain intersubjective stability of such relations is triadic. None of this denies the immense physical reality of two-system correlations. Bell inequalities are framed for pairs; bipartite entanglement is a laboratory staple. The claim is more architectural: when we want the structure in which perspectives can be compared and stabilized, the minimal self-sufficient architecture is three. The triangle is the first shape that can, in principle, stand as its own witness. Philosophically, this is reminiscent of Leibniz's relationism: space is an order of coexistences, time an order of successions; what is real is the web, not a pre-given stage populated by self-standing particles.[19]

RQM shows us the minimum closure of relation, the "dance for three," as the first structure that can stand as its own witness. But this description, important as it is, cannot by itself explain why there is anything at all rather than nothing. To speak of origins, we must turn to another realm of physics. Here, entropy becomes the next crucial category. From the standpoint of statistical thermodynamics, a system at the lowest possible entropy has no further direction to go but upward in variation. If, analogically speaking, classical theology describes God as perfectly full, unchanging, and without internal variation, then *creatio ex nihilo* can be understood as the act by which such a ground establishes a cosmos beginning at an

arbitrarily low entropy, from which the arrow of time and the unfolding of structure naturally follow.

V. How to Quantify Entropy

To be clear, entropy is not shorthand for "messiness." In statistical thermodynamics, entropy quantifies the number of physically distinct ways that a system can be arranged while presenting the same macroscopic face. In classical thermodynamics, we track the change in entropy by measuring heat flow either into or out of a system. These are two forms of the same quantity, and taken together, they account for how many real options remain compatible with what we choose to notice, and how heat flow has transformed the system.

With the shape of the "dance for three" in view—the first relation that can stand on its own—we can now ask what entropy is doing on this stage. First, a practical rule: what we notice matters. Entropy depends on the resolution of our description. If we only care about a pattern's outline, many rearrangements inside that outline won't change the count. If we zoom in and start attending to finer details, the count rises. Second, labels can mislead. In quantum physics, many particles are truly identical. If we mentally pin name tags on them, "this one is Alice, that one is Bob," and then swap the tags, we've created a difference that isn't physically real. Those swaps should not inflate the tally, which is why physicists don't over-count by labeling indistinguishable things.[20]

Now, apply this to the "dance for three." Suppose we describe only the shape: three identical particles linked so that every pair is connected, a simple triangle. If that shape is all we track—no name tags, no distances, no tiny internal details—then there is really just one pattern here. In that structural sense, the entropy is about as low as it can be. There are not multiple, genuinely different ways to have "a closed triangle of three identical things" once we've decided to ignore everything but the fact of closure.

We would be remiss if we failed to disclose two important points. First, if you notice more, you count more. The moment we start paying attention to how far apart the three are, to their relative angles, or to their little internal arrows (the physicist's spin), distinct possibilities appear. At that finer resolution, the triangle can be realized in more than one way, and entropy rises accordingly.[21] Second, the whole can be crisp even when the parts look fuzzy. A trio can be in a perfectly definite joint condition while each single member, taken by itself, looks blurred. A musical image may help here: the triad as a whole is heard as a stable harmony, but any one note played alone does not convey the fullness of that harmony. This is analogous to entanglement; the phenomenon exists only in the relations, not in the individual particles. Likewise, the Third Law of Thermodynamics states that when a system is at the absolute zero of temperature, if there is only one true resting arrangement available, its entropy will be zero. If several equally good resting states remain, a residual entropy remains. Our triangle-only description is like the first case: if you are *only* counting "is it a

closed triangle of identical things?" there is just one resting form; so the structural entropy is zero. However, the moment you admit more detail in the form of distances, orientations, or internal arrows, you create the possibility of multiple resting states, and some entropy results.

Read this way, the cautious summary is straightforward. Three identical particles, each in direct relation to the other, results in zero entropy. This is not a blanket claim about every microscopic detail, and taken in that sense, the physics and our larger argument line up. Order comes first, and variation plays upon it, which is exactly why the "dance for three" is such a natural stage on which the world begins to show its patterns.

VI. Author and Signature

We can now gather the strands with clarity, stating two claims and their boundaries. First, the authorial claim. The triune God, one God in three hypostases, is the ontological ground of all that is. The immutability confessed by James (no variation or shadow due to change) does not describe a sterile system, but the grounds of divine action. From God's immutable fullness flows creation and re-creation: "he brought us forth by the word of truth" (Jas 1:18). God's immutability is the condition allowing for the world's movements and transformations.

Second, the signature claim. Certain created forms carry a recognizable style, like Mozart's *Lacrimosa*. The minimal triadic closure in RQM, the minimal criterion for a system that can witness itself, is such a form, and so is entropy as a measure of transformation. These forms are not the Trinity. Rather, they resemble the triune life analogically in the way structural features can resemble their Author. The appropriate epistemic mode is recognition, not deduction. This is not anti-scientific. "Models and analogies play a key role in scientific discovery. They also contribute to the growth, improvement, and intellectual articulation of existing theories."[22] One recognizes the hand as one recognizes Mozart in the *Lacrimosa*: interval and cadence, relation and closure. The dance for three does not deduce God; it reveals God as Author in the way a composer is revealed by style.

Two guardrails protect our argument from both theological presumption and scientific positivism.

- Perichoresis: Classical theology describes the mutual indwelling of the divine persons with the term perichoresis. It names the triadic life that is internally complete, needing no *external* witness.[23] Each of the divine persons are completely the one God. The distinction between the persons is evidenced only by their relations, the relations of origin.[24] This confession reveals a proper analogy between the one unchangeable God and physics.
- Vestigia: Christian theology has long spoken of *vestigia Trinitatis*: "traces of the Trinity" in the created order. Augustine famously sought them in the mind's faculties of memory, understanding, and will.[25] We are not proposing to replace these with our argument from physics. Rather, we suggest that in a world now described by physics,

one may recognize additional formal traces that were not available to earlier ages. To do so does not collapse the Creator into creation. It simply takes seriously the premise that form reveals style.

VII. Conclusion

If our argument still feels audacious, consider how often science proceeds by inference rather than empiricism. A trained spectroscopist recognizes an element by its spectrum. These spectra are not proofs in the logical sense; they are signs that the spectroscopist has learned to recognize. Signature is not alien to rigor; you simply need to recognize the hand. When the first chord of the *Lacrimosa* sounds, we know the hand. The recognition of the signature does not tell us everything we wish to know, but it tells us enough to orient ourselves in the direction of the truth. The task for scientists and theologians alike is to become practiced hearers, lovers of form, so that when creation plays its opening bars, we may work together to recognize the Author.

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[1] Michael Polanyi, *The Tacit Dimension* (Chicago, IL: University of Chicago Press, 2009), 4. See also *Personal Knowledge* (1958), esp. "The Logic of Tacit Inference."
[2] Bonaventure, *Into God: Itinerarium Mentis in Deum of Saint Bonaventure*, trans. Regis J. Armstrong (Washington, DC: The Catholic University of America Press, 2020), chaps. 1–2.
[3] Carlo Rovelli, *Helgoland: Making Sense of the Quantum Revolution*, trans. Erica Segre and Simon Carnell (New York, NY: Riverhead, 2021), Part IV, "The Web of Relations that Weaves Reality," chap. "The Dance for Three That Weaves the Relations of the World" (U.S. ed., chapter begins p. 97; U.K. ed., Penguin, 2022 paperback, chapter begins p. 87).
[4] Walter Bauer, Frederick W. Danker, William F. Arndt, and F. Wilbur Gingrich, *A Greek-English Lexicon of the New Testament and Other Early Christian Literature*, 3rd ed. (Chicago, IL: University of Chicago Press, 2000), s.vv. "τρέπω," "τροπή."
[5] Homer, *Iliad*, 11.70.
[6] "τροπῶν ἀλλαγὰς" See Wisdom of Solomon, 7:18.
[7] Josephus, *Antiquities*, 10, 191–92.
[8] Rudolf Clausius, "Ninth Memoir: On Several Convenient Forms of the Fundamental Equations of the Mechanical Theory of Heat," in *The Mechanical Theory of*

Heat, with Its Applications to the Steam-Engine and to the Physical Properties of Bodies, ed. T. Hirst (London: John Van Voorst, 1867), 357.
[9] Emilio Segrè, *From Falling Bodies to Radio Waves: Classical Physicists and Their Discoveries* (New York, NY: Freeman and Company, 1984), 228–29.
[10] François Folie, "R. Clausius, sa vie, ses travaux et leur portée métaphysique." *Revue des Questions Scientifiques* 27 (1890): 421.
[11] Clausius, "Ninth Memoir: On Several Convenient Forms," 357.
[12] Douglas J. Moo, *James: An Introduction and Commentary*, vol. 16, Tyndale New Testament Commentaries (Downers Grove, IL: Inter-Varsity Press, 1985), 79.
[13] Moo, *James: An Introduction and Commentary*, 80.
[14] Thomas Aquinas, *Summa Theologiae*, I, 45, A. 5.
[15] Alfred Edersheim, *Sketches of Jewish Social Life in the Days of Christ* (London: The Religious Tract Society, 1876), 269.
[16] Carlo Rovelli, "Relational Quantum Mechanics," *International Journal of Theoretical Physics* 35 (1996): 1637–78; and Rovelli, *Helgoland*, esp. 97–100 on the relational thesis.
[17] On "public comparability" in RQM. Classic RQM (Rovelli 1996) eschews a global, observer-independent fact and keeps all statements relative to systems. Our use of "public comparability" is operational: it denotes the availability of physical records that multiple systems can interrogate. The Cross-Perspective Links proposal (Emily Adlam and Carlo Rovelli, "Information Is Physical: Cross Perspective Links in Relational Quantum Mechanics," *Philosophy of Physics* 1 (2023): 1–26.) is one way to regiment this idea, explicitly locating such links in record-bearing variables attached to observers/systems. We cite it as a formalization, not as a departure from the relational stance.
[18] Rovelli, *Helgoland*, Part IV, "The Web of Relations that Weaves Reality," chap. "The Dance for Three That Weaves the Relations of the World" (U.S. ed., chapter begins p. 97; U.K. ed., Penguin, 2022 paperback, chapter begins p. 87).
[19] Gottfried Wilhelm Leibniz, *Mr. Leibniz's Third Paper, being An Answer to Dr. Clarke's Second Reply,* in *A Collection of Papers Which Passed Between the Late Learned Mr. Leibniz, and Dr. Clarke, in the Years 1715 and 1716* (London, 1717), published online September 2006, The Newton Project, accessed September 17, 2025, https://www.newtonproject.ox.ac.uk/view/texts/normalized/THEM00230.
[20] Donald A. McQuarrie, *Statistical Mechanics* (Sausalito, CA: University Science Books, 2000), 68–73, 85–87.
[21] W. Dür, G. Vidal, and J. I. Cirac, "Three Qubits Can Be Entangled in Two Inequivalent Ways," *Physical Review A* 62, no. 6 (2000): 062314.
[22] Vern S. Poythress, *Symphonic Theology: The Validity of Multiple Perspectives in Theology* (Phillipsburg, PA: P&R Pub, 2001), 12.
[23] For discussion see John Damascene, *On the Orthodox Faith: A New Translation of An Exact Exposition of the Orthodox Faith*. St. Vladimir's Seminary Press Popular Patristics Series, number 62 (New York, NY: St Vladimir's Seminary Press, 2022), 95–96.
[24] Aquinas, *Summa Theologiae*, I, 30, A. 2.
[25] For discussion on Memory, Understanding, and Love, see Augustine, *De Trinitate*, Book XIV.8–12. For Memory, Understanding, and Will, see Book X.