# Popperian Fallibilism and the Discipline of Modal Restraint:

## Semantic Entailment, Spurious Necessity and Scientific Explanation

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**Abstract:** Philosophical reflection on scientific laws often struggles to distinguish between "mere" accidental regularities and "genuine" laws. This paper argues that the felt necessity attributed to certain scientific generalizations is not an empirical discovery of "physical necessity," but a result of definitive semantic entailment. By introducing a distinction between Descriptive (DS) and Definitive (DF) truth-characters—the foundational architecture of Nomic Anti-Monism (NA-M)—I diagnose "lawlikeness" as a category error termed "possibling": the projection of semantic closure onto empirical inquiry. Using the direct foil of Salmon's (1989) modal desiderata to illustrate this error, I apply a Gödelian constraint (1931) to the substitution of external necessity for internal inconceivability. I conclude that Popperian fallibilism constitutes a vital "modal hygiene" required to prevent scientific explanation from collapsing into dogmatic derivation.

*Keywords: Nomic Anti-Monism (NA-M), Scientific Explanation, Deductive-Nomological Model, Popperian Fallibilism, Modal Restraint, Semantic Entailment, Physical Necessity, Wesley Salmon.*

### 1. Introduction: Truth, Modality and a Persistent Methodological Confusion

Philosophical reflection on science has long been animated by a tension between contingency and necessity. Scientific claims are empirically grounded and revisable; yet some appear to exert an authority that goes beyond mere generalization. They appear to constrain not just what is, but what could be.

This paper argues that many persistent puzzles regarding laws of nature and scientific explanation stem from the silent conflation of two distinct truth-roles: the Descriptive (DS), which is empirically vulnerable and fallibilist, and the Definitive (DF), which is framework-constitutive and entailment-laden. Confusion arises when the demands of the latter are projected onto the former, generating "spurious necessity." This diagnosis reframes Popperian fallibilism (Popper, 1959) as a structural constraint: one of the primary functions of science is to resist semantic entailments—however well-entrenched—hardening into unquestionable, test-immunized dogma.

### 2. The Salmon Foil: The Hunger for Physical Necessity

The Deductive-Nomological (DN) model's perceived inadequacy is often traced to its inability to distinguish between accidental truths and genuine laws (Hempel, 1965). Salmon (1989) famously articulated the desiderata for lawhood:

> "If a statement is to express a law of nature it must be true. The question is, what characteristics, in addition to truth, must it possess? ... The ability to support counterfactuals is another... Modal import is another: laws delineate what is necessary, possible, or impossible. We are not talking about logical modalities, of course; we are concerned with what is physically necessary." (p. 135).

Salmon's demand for "physical necessity" represents a fundamental methodological turning point—a request for science to provide a "reason" that exceeds the "cause."

#### A Diagnostic Asymmetry: Gold vs. Uranium

Consider two statements of identical logical form, famously discussed by Reichenbach (1947) and later popularized by Salmon (1989):

- **(G):** There exists no naturally occurring pure gold sphere greater than one mile in diameter.
- **(U):** There exists no naturally occurring pure uranium (U-235) sphere greater than one mile in diameter.

Both are universal negative existentials. Both are true. Yet (G) is read as a contingent report of rarity; it is "absent." (U) is read as a non-accidental prohibition; it is "impossible."

### Why Standard Explanations Fail

Appeals to "structural necessity" (Dretske, 1977; Armstrong, 1983) or “invariance under intervention” (Woodward, 2003) merely defer the problem: is that structure itself contingently necessary (given how the world happens to be) or necessarily necessary? If the latter, we continue to be owed an account of how an empirical structure acquires immunity to revision. To ask *why* the structure is as it is keeps the demand for explanation alive; structural necessity functions not as a resolution, but as a terminological stopgap that begs the question of empirical necessity (van Fraassen, 1989).

### The Source: Entailment Pressure

The necessity of (U) originates not in the world, but in **meaning**. Given our explanatory framework, "pure uranium" is not a neutral descriptive term; it has undergone **subterranean semantic hardening**, where the descriptive observation of instability has been promoted to a definitive attribute (critical mass) of the term itself. This definitive exclusion precludes macroscopic uranic stability as-if by empirical necessity; which however persistent observations of instability cannot modally support. In contrast, "gold" carries no such restrictive entailments. Salmon (1989) mistakes the internal closure of the Definitive (DF) for Descriptive (DS) external necessity. As well, he misconstrues such mistaken (DS) necessity as a goal of scientific discovery.

### The Gödel Lemma: The Limits of Modal Substitution

To those who would ground "physical necessity" in modal semantics (Lewis, 1973), we must apply a Gödelian constraint. Any conceptual system sufficient to ground modal claims faces a choice between **Consistency** (internal coherence) and **Completeness** (accounting for all possibilities). The "necessity" felt in the uranium case results from choosing **Consistency**—the integrity of our definition—over the **Completeness** of the empirical world.

"Conceivability" (internal DF consistency) can never be traded for "necessity" (external DS completeness). The bridge between them is a formal category error.

Salmon mistook the internal closure of the Definitive (DF) for Descriptive (DS) external necessity—he displaced empirical confidence with a *logical must* and called the result *physical law*.

## 3. The Architecture of Truth-Characters

We must distinguish between these truth-roles through their **asymmetry of failure**:

- **Descriptive (DS):** Evaluation by correspondence; failure results in **revision**. (e.g., finding the gold sphere).
- **Definitive (DF):** Evaluation by entailment; failure results in **collapse**. (e.g., uranium stability violating the concept).

The uranium anomaly is an instance of **impossibling**: a methodological failure to distinguish between what the world forbids and what our meanings preclude. We mistake the "click" of a locking definition for the "thud" of a physical barrier.

The inconceivability of macroscopic uranium spheres is indicative. Finding one such could not be regarded as an isolated empirical refutation; it would logically necessitate some significant replacement of the definitive framework that had made such a fact inconceivable.

### Explanation vs. Derivation

Scientific explanation typically utilizes **DF-explanans** (definitions, math) to account for **DS-explananda** (observations). If the explanandum is pulled entirely into DF-space—if a large uranium sphere is deemed "impossible" due solely to incoherence by definition—explanation evaporates. Thereafter explanation is replaced by mere **derivation**, where the conclusion is already "baked into" the premise.

## 4. Fallibilism as Modal Hygiene: The Popperian Mandate

This lawlikeness is precisely not what science seeks; it is what science must resist. Popperian fallibilism (Popper 1959) is not preference for doubt; it is **modal hygiene**—the disciplined scrubbing of DF-residue from DS-instruments to ensure that *Already-ness* is not mistaken for *Forever-ness*. It is the realization that while a definition may be *Forever*, an observation can only ever be *Already*. So far—but not **necessarily** further.

### The Resistance to Closure

Fallibilism demands disciplined refusal to allow the "click" of DF-closure to colonize DS-inquiry. As theories survive refutation, they naturally "drift" from the hypothetical to the taken-for-granted. This drift may be productive in generative contexts like hypothesis formation, but it is methodologically hazardous in evaluation.

### The Hazard of Authority

The hunger for "certitude and authority beyond contingency" is a methodological hazard. When we demand that science satisfy Salmon's desiderata, we are asking for **DF-closure** in a context that requires **DS-vulnerability**. One of the primary functions of science is to resist semantic entailments—however well-entrenched—from hardening into unquestionable dogma. Yet protection against such hazards must not be sought in **DF-softening**.

### The Strategy of Revision vs. The Trap of Softening

This distinction provides a powerful normative instruction for scientific and logical practice:

- **DF-Softening (The Error):** Attempting to tolerate local incoherence or "vague" entailments to avoid collapse. This leads to the "dilution" of provability and the loss of evaluative traction.
- **DF-Revision (The Popperian Mandate):** Treating the **Local Collapse** as a "Hard Refutation" of the current definitive framework. We maintain the rigor of the DF-character but change the axioms.

This is exactly how science progresses: we don't make the math of Newtonian mechanics "softer" to account for Mercury's orbit; we replace the entire DF-structure with General Relativity. The "Hardness" is preserved, but the "Map" is revised. Ideally.

## 5. Conclusion: The Limits of Modal Restraint

The persistent demand that scientific explanations provide "reasons" (DF) rather than "causes" (DS) reflects a psychological need for definitive closure rather than a methodological requirement of inquiry. By unmasking "natural laws" as instances of sufficient entailment pressure, we preserve the power of the DN model (Hempel, 1965) without the need for metaphysical inflation.

Science succeeds not by uncovered necessity, but by maintaining a rigorous "modal restraint"—ensuring that the library of our meanings never overrules the laboratory of our observations; and that our stories about the world remain answerable to our experience in the world.

**NA-M Truth-Categorical Table**

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**Epilogue**

The diagnostic distinction between *alreadyness* and *foreverness* is no mere theoretical nicety; it brings potential resolution to more than one 20th-century deadlock.

Over thirty years ago, under mentorship of Joseph Agassi, the author attempted to rescue the **Deductive-Nomological (DN) model** by arguing that "empirical necessity" was methodologically superfluous to explanatory force. That rescue attempt (for historical interest see Postscript fragment) correctly identified that we rely on our best hopes—the theories we retain, that have been selected over theoretical competitors by critically surviving the most rigorous falsification challenges. But hope is not necessity. Confidence is not necessity. However-long retention is not necessity. And while necessity may not itself be necessary in scientific explanation—it does seem rather desirable. It seems like a nice feature to have—not a bug. If not from the contingencies of scientific explanation—wherefrom does it issue? Whence does it hail?

Agassi insisted the author's attempt be submitted for publication. The author refused since the attempt was not "good enough." How not? Though fallibilism had been correctly defended and justificationism resisted, yet the (however superfluous) anomalous modality of Uranium remained hanging—unexplained. And failure to explain enigmatic necessity under a scientific explanation thesis was clearly not good enough. Agassi was angered and, shortly thereafter, communication with the author ceased.

Yet, during years since, the author never ceased thinking about it; until, gradually, over three intervening decades, an idea emerged. What if necessity is not a feature of the world discovered in the lab—but a feature of language hardened by the library? Perhaps necessity arises from persisting explanatory accounts via subterranean arti-factualization in ordinary thought and language. From that idea a theory emerged. Nomic Anti-Monism (NA-M) posits that the language of thought is definitively (DF) governed by rich entailment relations; from weak structural similarity insinuations through slightly stronger conjunctive persistence, to somewhat stronger metaphors (like slope-fixing tangents at points on yet unknown curves), stronger still co-relations, yet stronger conditionalities, still stronger quantitative equalities, all the way to strongest identity relations.

No (DF)-variance listing can prove remotely exhaustive. From weakest to strongest, the language of thought posited under NA-M is near-endlessly, fluidly, fluently entailment-varied. It is so richly entailment-varied that the descriptive (DS) language of uncharted experience is not obviously underdetermined by it. There are, however, characteristics which distinguish the entailment-driven language of thought from the causality-tracking language of experience. Diagnostically, truth-categorically, definitive systems fail differently from descriptive orientations under contradiction. (DS)-being is expected to persist when falsely described. But (DF)-meaning collapses under contradiction. Under self-contradiction even (DF)-evaluability collapses. Whether weakly defined or rigorously axiomatized, definitive systems lack any being outside (inconsistent with) their entailed

meanings. Meaning-coherence is their sole being, bound to collapse in puffs of nothingness under contradiction. Conversely, however, (DF)-entailment is immaculately, logically geared to supply us with all necessities (DS)-contingency cannot. Including the macroscopic instability of pure Uranium. That's the definitive origin of Salmon's truth-categorically dislocated *Physical Necessity*.

How does pure Uranium acquire macroscopic instability as a (DF)-necessity under NA-M? Thus: features of long-retained theories become arti-factualized in ordinary thought and language. There, as artifacts of ordinary language, they are integrated then framed definitively—thereby providing counter-factual support, modal import and sensed necessity. Their methodological (DS)-contingency is discarded. In ordinary thought and language, long-standing theories gradually cease to be "just theories". None of which is to promote arti-factualization as a (DF)-origination mechanism—only as a plausible source of (DF)-hardening. What some may call paradigmatic entrenchment.

Further clarifications, implications and ramifications of NA-M remain to be explored.

The goal here is to introduce NA-M as a far-reaching diagnostic tool—not to resuscitate the late DN model. It is too late to resuscitate. But it is nevertheless worth noting how, under NA-M perspective, fatal-seeming criticisms of the DN model no longer seem critical.

Consider, for instance, Bromberger's (1966) flagpole and shadow problem of explanatory asymmetry. *Explanans* and *explananda* could be reversed to account for flagpole height by shadow length. Yet intuitively, obviously, the explanation cannot be reversed. The flagpole's height cannot be explained by the length of its shadow.

It requires extreme cherry-picking to isolate initial conditions wherein explanans and explananda may be legitimately interchanged. Incidence of the sun and shadow length are variable. Flagpole height is relatively (though not relativistically) constant. We must remove the arrow of time and freeze reference framing within a single, indivisible instant.

In that single, timeless instant it remains intuitively obvious that flagpole height cannot be explained by shadow length. But why not? We removed everything from consideration—including the arrow of time. What remains to produce such certitude that flagpole height cannot be accounted by shadow length? Under NA-M the answer is clear. What remains is what we cannot remove. The same sort of thing that produced the felt necessity of Uranium instability: (DF)-hardened entailment pressure.

Shades lack causal agency. Otherwise they would not be (i.e., *mean*) shades. That is far definitively stronger (more (DF)-pressing and hardened) than the instability of Uranium. If stable Uranium is like meeting a widowed bachelor then shade causal agency is like meeting one who seeks trial separation.

The point here is not to erode (DS)-confidence in contingently absent shade causal agency. The point is that scientific explanation must resist bolstering even shades of epiphenomenal being with shades of (DF)-necessary meaning.

(DS)-refutation truth-categorically cannot provide permanent (DF)-closure—nor ontological *foreverness*. The Cartesian ether, for instance, was effectively closed out by the Michelson-Morley results and subsequent Einsteinian reframes. It was not definitively or ontologically closed out, however. Should wider coherence of modern cosmology (e.g., Quantum Vacuum Energy, the Higgs Field, Dark Matter or Energy candidacy when all else fails) require medium-like structural explanations, "ether" remains among conceivable explanans. So should shade causal agency. Not as superstition—but as modal restraint.

If the shadow and flagpole asymmetry is due to failure of modal restraint rather than of deduction, then, under truth-categorical NA-M clarification, seeming DN criticisms are revealed as commendations. Salmon's desiderata and the desiderata of fallibilist methodology do not coincide. To the contrary: fallibilist hygiene requires science to resist colonization by our hunger for final (DF)-closure, for reasons over causes—by our need to avoid teleological nullity. That hunger must not be satiated by science. That need must be fulfilled elsewhere. The DN model is correct to discount such felt necessities. That's a central feature—not a bug. Hempel's "failure" was, in fact, an unrecognized act of modal restraint—ensuring our stories about the world remain answerable to our experience in the world.

**Postscript**

**Scientific Explanation and the Deductive-Nomological Model: Historical Perspective, the Modern View and a Defence — Fragment**

… Quite recently Wesley Salmon summarized the difference between generality and lawlikeness thus: "The problem that arises in this context is to distinguish between laws and *accidental generalizations*. This is a crucial issue, for laws have explanatory force, while accidental generalizations, *even if they are true*, do not."[85] Less recently, Popper, summarizing a 1949 argument, wrote,

> I believe Kneale's point can be put as follows. Although universal statements are *entailed* by statements of natural law, the latter are logically stronger than the former. They do not only assert 'All planets move in ellipses', but rather something like 'All planets move *necessarily* in ellipses'.[86]

Regardless of newsworthiness, however, the criticism has been widely accepted as correct. For instance, Popper wrote:

> I think that all this is intuitively acceptable ... And I think that it is quite possible and perhaps even useful to speak of 'natural necessity' or of 'physical necessity', in order to describe this character of natural laws, and of their logical consequences.[87]

Salmon, expressing what appears to have become the consensus position, has provided the following overview:

> If a statement is to express a law of nature it must be true. The question is, what characteristics, in addition to truth, must it possess? *Generality* is one such characteristic: laws must apply universally and they must not contain special provisions or exceptions for particular individuals or groups. The *ability to support counterfactuals* is another: they must tell us what would happen if... *Modal import* is another: laws delineate what is necessary, possible, or impossible. We are not talking about logical modalities, of course; we are concerned with what is *physically* necessary..[88]

Unfortunately, while there appears to be consensus that statements of law and universal generalizations differ, when it comes to isolating the difference there is no solution in sight. On Salmon's characterization of this state of affairs, "The unresolved question is this: is there any objective distinction between laws and true accidental generalizations? Or is the distinction wholly psychological, epistemic, or pragmatic?"[89] It is not surprising that Salmon considered the question unresolved. The difference has been hunted over a multiplicity of divergent grounds: Popper sought for it in physical necessity; David Lewis and others seek to find its measure via possible

world metrics; Dretske and others endorse inventing new logical connectives in order to better describe it; Salmon and others attempt to circumnavigate it via appeal to physical production and transfer of energy; Bas van Fraasen thinks it a matter of mere pragmatics and best forgotten; and this list is by no means exhaustive. It seems not unreasonable to conclude that the thrust of this criticism, aimed directly at the modern answer to the question of explanatory adequacy and at times not even indirectly at the Deductive-Nomological model of explanation, has had much to do with bringing it about that "The DN model is widely regarded as having been discredited,"[90] despite the fact that it persists; and ".. persists as the defining model of the field."[91] Below, assisted by some incisive arguments and striking illustrations put forward by van Fraasen, I shall attempt to find some small clearing in the forest.

## A Reply to the Chief

I shall argue that when it comes to distinguishing between statements of law and universal generalizations, it is difficult to disagree with van Fraasen that the distinction is a matter of pragmatics; however, that contrary to Salmon's position,[92] we have no need to come to a final distinction. I shall begin with an illustration employed by van Fraasen.

I begin with the following illustration employed by van Fraasen:

1. All solid spheres of enriched uranium (U235) have a diameter of less than one mile.
2. All solid spheres of gold (Au) have a diameter of less than one mile.[93]

Here we have two universal statements, both allegedly true. We seem to have no hope of finding some systematic syntactic or semantic divergence, upon which we might hinge an account capable of distinguishing universal generalizations from statements of law, between them. Yet, the former might well be a statement of law while the latter is not. Quite possibly, there are no relatively large spheres of gold anywhere and anywhen; but there might be. If the latter statement is true it is only, on our best guess, accidentally true. On the other hand, the former statement might well have the ability to support counterfactuals, might have modal import and might even be physically necessary. Solid spheres of enriched Uranium are notoriously unstable and are known to reach critical mass rather prior to one mile diameter. On strength of this illustration, van Fraasen argued:

> Another moral that is very clear now is that laws cannot be simply the true statements in a certain class characterized in terms of syntax and semantics. There is no general syntactic or semantic feature in which the two parallel examples differ. So we would go wrong from the start to follow such writers as Goodman, Hempel, and Davidson in thinking of the laws as the true 'lawlike' statements.[94]

This argument clears some room in the forest. It is difficult not to agree with van Fraasen that syntactic and semantic elaboration, in efforts to isolate the difference between statements of law and universal generalizations, is not a promising enterprise. On the other hand, there seems to be an option available not to remain with van Fraasen all the way enroute to his conclusion that ".. the concept of a law of nature is a *vestigial* concept in modern science,"[95] and is best abandoned. I shall turn to this option below.

I shall argue that the option is open to join with both van Fraasen that the difference between universal generalizations and lawlike statements is a matter of pragmatics and with Popper that generalizations play a proper and indispensible role in bringing about adequate explanation; that universal generalizations provide sufficient nomic force -- are lawlike in the sense that they permit attribution of Humean causality -- to propel explanation even if they are false or only accidentally true. I shall begin by taking another look at the illustration employed by van Fraasen. Here, nothing seems to have changed. One continues to be impressed that the former statement is lawlike. But perhaps this is no *mere* impression. It seems no leap to conjecture that the impression results

from the viewer's high confidence in some particular theories of physical chemistry and physics; even if the viewer knows little else other than that existence of such a sizeable sphere of enriched uranium would violate the theories and that the theories have been highly corroborated. Yet, even granting that no-one unfamiliar or lacking sufficient confidence in the theories would be struck by a difference in lawlikeness across the two statements; this accounts for nothing more than subjective impression -- a matter of pragmatics. Nevertheless, if we recall the Popperian shift from epistemology to methodology, this pragmatic difference might turn out to be an artifact of sensible methodology. I shall elaborate below.

I shall now elaborate on my conjecture. It is the Popperian view that we learn from experience, via sequences of conjectures and refutations, by selective rejection of hypotheses; that, as we learn, our theories are elaborated; and that we choose among theories by selectively rejecting those theories which have not best survived our efforts to falsify them.[96] Returning again to the apparently lawlike statement concerning the uranic sphere, I suggest that the

appearance of lawlikeness is due to that statement falling within the domain of a theory which has best survived our efforts to falsify it such that we can not reject the statement without also rejecting the theory; which latter we are not prepared to do. If so, this implies that the difference, isolated by Dretske, between generalizations and lawlike statements is not a function of semantic or syntactic features of those statements; but rather a function of the statements' membership in the class of predictions arising from theories confidence in which we are least willing to abandon. However, as Dretske might put it, this suggestion alone is not newsworthy.

Alone, my suggestion is not newsworthy. It constitutes no more than agreement with van Fraasen that the answer to Salmon's question -- is there any objective difference between universal generalizations and lawlike statements, or is the difference a matter of pragmatics? -- is that the difference between generalizations and lawlike statements is pragmatic. But if we can not find an objective difference then we feel at a loss. If we take our cue from Salmon and a host of others -- that laws have explanatory force while accidental generalizations do not -- we must give up on the species of explanation which finds lawlike statements indispensible; hence, on the modern answer to the question of explanatory adequacy. This would not be a complete loss. We could join with van Fraasen in seeking elsewhere or not at all for explanation and agree with him that, where scientific inquiry is concerned, ".. laws of nature are [not] the targets reached, or even aimed for..."[97] Perhaps, however, prior to taking our cue from Salmon, we might ask whether it is indeed the case that accidental generalizations have no explanatory force, that therefore we must find a way to distinguish between them and lawlike statements, and that the difference had better be objective in order for us to have the capacity to guarantee that we can distinguish reliably.

I shall now reiterate Popper's answer to the question "Must we find an objective difference between generalizations and lawlike statements?" His answer is *no*.[98] I shall not go into detail -- this ground has already been covered. However, I shall be arguing that we do better to take our cue from Popper than from Salmon; and the following conveys the flavour of Popper's answer -- his shift from epistemology to methodology:

> For justificationists a hypothesis has to pass tests, or be confirmed, or something of the sort, if it is to be admitted to the realm of scientific knowledge; if it fails these tests, or is disconfirmed, or even if it fails to be confirmed, it is excluded. Popper, in contrast, subjects a hypothesis to tests only after it has been admitted. If it fails any of the tests to

> which it is put, then it is expelled, removed from science; if it passes them all, then nothing happens -- that is to say, it is retained. The passing of tests therefore makes not a jot of difference to the status of any hypothesis...[99]

If we take our cue from Popper's answer, we may abandon the expectation that explanatory force hinges upon a guarantee regarding the non-accidental character of our generalizations. Just as we do not insist on the truthful character of a hypothesis prior to admitting its *scientificness*, so we do not insist on the non-accidental character of a hypothetical universal generalization prior to admitting its *explanatoriness*. That is not where explanatory force is to be found for, if we take our cue from Popper, the character of our falsifiable hypotheses is conjectural on all dimensions -- not given to guaranteeing truth or non-accidentality. Rather, we find explanatory force in the statements which characteristically survive our criticisms best -- where scientific inquiry is concerned, our attempts to falsify the statements. If van Fraasen is right, where we find explanatory force is a matter of pragmatics; but, if we take our cue from Popper, this does not make us irrational. We depend not on a guarantee but on a hope for non-accidentality; and our greatest hope is with statements and theories which, on our best genuine efforts, are most resistant to falsification. This is old news. What does seem newsworthy, however, is the effectiveness with which the modern answer to the question of explanatory adequacy is reinforced[100] if we take our cue from Popper, against the type of criticism put forward by Dretske -- which criticism, I have argued, counts against the modern answer directly while, of all criticisms against the Deductive-Nomological model, it is, albeit indirectly, the most damaging. If so, we can join with van Fraasen in acknowledging the difference between lawlike statements and generalizations to be a matter of pragmatics but part ways prior to concluding that, where scientific inquiry is concerned, laws of nature are not even the targets aimed for. Where scientific inquiry is concerned, we require not only rigorous refutation but a wealth of bold conjecture as well; universal generalizations perhaps constitute the boldest conjectures; and we are free to hope that our generalizations express laws rather than persistent accidents. We must keep in mind, however, that when we allege non-accidental truth regarding some state of affairs we offer a hope rather than a guarantee; regardless of the confidence we feel, in light of highly corroborated theories, at the time of alleging. Hempel was content to abandon guaranteed truth as part cost of admission to the class of adequate explanations. On Popperian grounds it is rational to abandon guaranteed non-accidentality; as with truth, our impressions of what is and

is not accidental vary with our information, across our background theories and over time. It should not be so difficult to accept that where inquiries about the world are concerned, all our evidence is circumstantial. Finally, if this is indeed newsworthy, it ought not to be. Popper's cue has been placed in plain sight some while ago.

## Conclusion

In conclusion, it seems that some themes are historically repetitive. In answering a prototypical question of explanatory adequacy, Descartes insisted that explanations are adequate which provide us with certitude. Kant did not insist; rather, he was content that our evidence about the world is forever circumstantial. He stressed a methodological principle designed to assist in extracting maximum possible certitude from explanations concerning empirical states of affairs. Then, under the influence of Mill, the question itself matured; and so have the answers. Now, workers on the side of justification and confirmation do not insist on global certitude. They persist, however, that adequate explanation provide us with at least *some* certitude; particularly, for instance, that what has been explained does not come about by mere accident. Popper and others on the side of falsification do not insist. They are content that our evidence about the world is forever circumstantial. They stress methodology designed to clarify how we learn, via explanations, about empirical states of affairs; particularly, how it is that we continue to learn absent all certitude. In brief, given that no one has credibly guaranteed us any certitude, it seems preferable to adopt a fallibilist stance when designing criteria of explanatory adequacy and choosing adequacy desiderata for explanation; thus we continue to learn.

**References**


Armstrong, D. M. (1983). *What is a Law of Nature?* Cambridge University Press.

Bromberger, S. (1966). Why-Questions. In *Mind and Cosmos: Essays in Contemporary Science and Philosophy*. (pp. 86 – 117). Collier-Macmillan.

Dretske, F. I. (1977). Laws of Nature. *Philosophy of Science, 44*(3), 248 –268.

Gödel, K. (1931). On formally undecidable propositions of Principia Mathematica and related systems. In B. Meltzer (Trans.), *On Formally Undecidable Propositions of Principia Mathematica and Related Systems* (1962 ed.). Basic Books.

Hempel, C. G. (1965). Aspects of Scientific Explanation. In *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science* (pp. 297–330). Free Press.

Lewis, D. (1973). *Counterfactuals*. Blackwell.

Popper, K. R. (1959). *The Logic of Scientific Discovery*. Hutchinson.

Reichenbach, H. (1947). *Elements of Symbolic Logic*. Macmillan.

Salmon, W. C. (1989). *Four Decades of Scientific Explanation*. University of Minnesota Press.

van Fraassen, B. C. (1989). *Laws and Symmetry*. Oxford University Press.

Woodward, J. (2003). *Making Things Happen: A Theory of Causal Explanation*. Oxford University Press.