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Transreading the Resonance between Science, Philosophy, and Poetry

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During the early twentieth century, such key figures as Albert Einstein, Arthur Eddington, Niels Bohr, Werner Heisenberg, and Kurt Gödel redrew the limits of knowledge and, in doing so, reshaped prevailing scientific and philosophical conceptions of reality. In parallel, poets William Empson and Hans Magnus Enzensberger drew on concepts from physics and mathematics into literature, including the idea of the "finite but unbounded" (Eddington 80). Inspired by these historical encounters, this article undertakes a comparative inquiry into Empson's "Doctrinal Point" and Enzensberger's "Homage to Gödel", placing them in dialogue with paradoxes articulated by philosopher-scientists through a method I call transreading.[1]

Transreading is proposed here as a distinct form of interdisciplinary practice which integrates four mutually informing activities: attentive reading, transdisciplinary translation, transcultural hermeneutics, and creative expression, such as conceptual reframing, translation choices, and constructive interpretation**.** Attentive reading expands close reading into participatory observation, probing complementary perspectives to realise a text's latent potential. Transdisciplinary translation generalises translingual practice to dissolve disciplinary boundaries and test the portability of concepts between science, philosophy, and poetry. Transcultural hermeneutics bridges disparate traditions and weaves individual works into a constellation to interpret them anew. Creative expression unfolds these newly revealed interrelations while projecting them to a broad interdisciplinary readership.

For expository purposes, the article is structured in five stages, each foregrounding a pivotal tension in the dialogue between scientific and poetic imagination: first, the challenge of venturing beyond the measurable into the unknown; second, the critique of tautology and determinism; third, the clash between axiomatic system and intuitions; fourth, the paradoxical emergence of uncertainty; and finally, the reciprocity of observer and observed. Together, these stages trace a trajectory of modern thought from Einstein's critique of dogmatic propositions and Eddington's metaphor of the "leaky bucket", through Empson's rebuttal of scientific hubris and Gödel's subversion of Hilbert's formalist programme, to Enzensberger's revelation of noncontradiction as incompleteness and Bohr's complementarity of spectator and actor.

By assembling these perspectives within a single analytical framework, the article aims to show how science, philosophy, and poetry – having followed divergent paths – can be read as converging responses to shared epistemological limits. Rather than resolving complexity, this approach foregrounds it, inviting reflection on uncertainty, resonance, and the conditions of knowledge across disciplinary boundaries.

Unknown and Unknowable: "It is Hard to Empty the Well of Truth with a Leaky Bucket"

When Einstein Walked with Gödel: Excursions to the Edge of Thought (2018) crystallises the joint venture of two leading intellectuals at Princeton in the 1940s:

> The two would talk animatedly in German on their morning amble to the institute and again, later in the day, on their way homeward […] If Einstein had upended our everyday notions about the physical world with his theory of relativity, the younger man, Kurt Gödel, had had a similarly subversive effect on our understanding of the abstract world of mathematics. (Holt 3)

Heisenberg, the German physicist who won the 1932 Nobel Prize and built his philosophy on his 1927 formulation of "uncertainty relations", recalled an equally daring excursion. His first personal encounter with Einstein in Berlin in 1926 liberated him from an idea central to his research up to that point, namely, "a physical theory should contain only quantities that can be directly observed":

> To my astonishment, Einstein was not at all satisfied with this argument. He thought that every theory in fact contains unobservable quantities […] when I objected that in this I had merely been applying the type of philosophy that he, too, had made the basis of his special theory of relativity, he answered simply: "Perhaps I did use such philosophy earlier, and also wrote it, but it is nonsense all the same". (Heisenberg, *Encounters with Einstein* 112-14)

Einstein's commitment to questioning dogmatic propositions entailed a revision of his own philosophy: "It is the theory which decides what we can observe". Months later, when wrestling with "hopelessly complicated problems" in Copenhagen, Heisenberg recalled Einstein's revised philosophy and "was immediately convinced that the key to the gate that had been closed for so long must be sought right here". He then formulated the "uncertainty relations" that "established the much-needed bridge between the cloud-chamber observations and the mathematics of quantum mechanics" (Heisenberg, *Physics and Beyond* 77-78).

Heisenberg's accounts reveal not only Einstein's quest for the philosophical foundation of scientific phenomena, but also his capacity to adapt his position to the constantly evolving ecology of the known and the unknown. Both revelations resonate with the illustration of "scientific discovery" by Eddington, the English astrophysicist who provided early observational confirmation of Einstein's theory of relativity:

> Scientific discovery is like the fitting together of the pieces of a great jig-saw puzzle […] The scientist has his guesses as to how the finished picture will work out […] but his guesses are modified from time to time by unexpected developments as the fitting proceeds […] It is not so much the particular form that scientific theories have now taken […] as the movement of thought behind them that concerns the philosopher […] Amid all our faulty attempts at expression the kernel of scientific truth steadily grows; and of this truth it may be said – The more it changes, the more it remains the same thing. (Eddington 352-53)

The final line of *The Nature of the Physical World*, Eddington's 1927 Gifford Lectures at the University of Edinburgh, evokes two ancient paradoxes: "Changing, it remains at rest" by the pre-Socratic philosopher Heraclitus (165) and "non-change in change, change in non-change" by the Daoist wiseman Zhuangzi, traditionally dated 4th century BC (Zhuangzi 234, trans. HZ). This concordance exemplifies "the ulterior object" Eddington disclosed in his introduction:

> I shall not leave out of sight the ulterior object which must be in the mind of a Gifford Lecturer, the problem of relating these purely physical discoveries to the wider aspects and interest of our human nature […] I am convinced that a just appreciation of the physical world as it is understood today carries with it a feeling of open-mindedness towards a wider significance transcending scientific measurement […] and in the late lectures I shall try to focus that feeling and make inexpert efforts to find where it leads. (Eddington xvi)

Eddington's "inexpert efforts" were seen by some as representative of the "philosophical speculations of modern physicists", which "are not invested with the authority that attaches to the pronouncements of these eminent men of science upon questions which belong properly to their sphere" (Joad 95). Yet, by venturing into foreign spheres, Eddington embodied the audacity Heisenberg saw in Columbus: "His most remarkable feat was the decision to leave the known regions of the world and to sail westward, far beyond the point from which his provisions could have got him back home" (Heisenberg, *Physics and Beyond* 70). Eddington's transdisciplinary pursuit allowed him to achieve "a higher order" as recognised by the English mathematician Edmund Whittaker. Contrasting Eddington's poetic insight with "logical criticism", Whittaker pinpointed "a quality which is found […] in great poets, of having flashes of insight which reveal to them things which are beyond the range of exact knowledge" (Whittaker 212-13).

The spectrum of the Gifford Lectures shed more light on Eddington's mission to transcend scientific measurement. "Unquestionably the world's most highly regarded in their field", this series was established in 1887 to promote the study of "natural theology in the widest terms" (Spurway 935). On its Edinburgh stage, the American psychologist William James delivered *The Varieties of Religious Experience* (1902), expounding concerns he implied in *The Principles of Psychology* (1890), where he introduced the term "complementary" to denote the relationship between mutually exclusive parts, into which "*the total possible consciousness may be split*" (James 206). Following Eddington, the English mathematician Alfred Whitehead delivered *Process and Reality* (1928), a "philosophy of organism" that considers attending to reality as "the process of becoming" (Gifford, "Alfred North Whitehead", n.pag.). In 1948, Bohr, the Danish physicist who won the 1922 Nobel Prize and built his philosophy on his 1927 formulation of "complementarity", delivered *Causality and Complementarity*, concluding that "quantum mechanics requires a reframing, one that encompasses the richness of physical experience and the mystery that remains" ("Niels Bohr" n. pag.). Against this backdrop, Eddington's *Nature of the Physical World* "tinged quantum physics with mysticism in limpid prose" (Spurway 937).

The interconnectedness of these Gifford Lecturers is revealing. Both Bohr's attention to complementary phenomena and his attempt at complementary interpretations resonate with James. When asked by Thomas Kuhn, the American historian noted for *The Structure of Scientific Revolutions*, what Western philosophers he had read, Bohr named James: "the stream of thought" in *The Principles of*

Psychology "shows that it is quite impossible to analyse things" when "they are so connected that if you try to separate them from each other, it just has nothing to do with the actual situation" (Bohr, "Interview", n. pag.). Instead, "the integrity of living organisms and the characteristics of conscious individuals and human cultures present features of wholeness", as exemplified in the "feature of *wholeness* inherent in atomic processes" (Bohr, *Essays* 2, 7).

Had Kuhn widened the horizon to incorporate the East, Bohr may have named Laozi: traditionally dated 5th century BC, the legendary Daoist thinker attends less to the things separated than to their interplay and continuum, which forms a stream that *is* "the actual situation". Laozi differentiates the way of seeing the parts, i.e., analysis and division, from the way of seeing the *whole*, i.e., synthesis and unification. This deliberate, dynamic reframing – reminiscent of Bohr's "reframing" that encompasses physics and mystery – is concealed at the opening of the *Daodejing*:

> The word that can be worded isn't the eternal word
> The name that can be named isn't the eternal name
> The unnamed is the beginning of heaven and earth
> The named is the mother of all things
> Without desire observe what is subtle
> With desire observe what is manifest (Laozi 1, trans. HZ)

Analogous to Bohr's and James's convergence on complementarity, Eddington and Whitehead met on the common ground of sciences and humanities. The linkage between "scientific symbols" and "familiar conceptions" permits two paths: to traverse from physics and mathematics to philosophy and religion, and vice versa. Eddington's *Nature of the Physical World* takes the first path and "may in most respects seem diametrically opposed to Dr Whitehead's widely read philosophy of Nature"; nonetheless, Eddington considered Whitehead "an ally who from the opposite side of the mountain is tunnelling to meet his less philosophically minded colleagues" (Eddington 247-50).

Both entrances merge into what Laozi calls the "harmony of dark and light", i.e., the two generative forces of *yin* and *yang* (Laozi 42), or what Heraclitus calls "a backward-turning fitting-together (*harmoniê*), as of a bow and a lyre" (Heraclitus 161). Whitehead's *Religion in the Making* (1926) exhibits "the inevitable transformation of religion with the transformation of knowledge", underlining "the foundation of religion on our apprehension of those permanent elements […] apart from which there could be no changing world" (Whitehead 1). Conversely, Eddington concluded from the "arguments from modern science" that "religion first became possible for a reasonable scientific man about the year 1927", which "will certainly rank as one of the greatest epochs in the development of scientific philosophy" for "the final overthrow of strict causality" (Eddington 350):

> The deliberate frustration of our efforts to bring knowledge of the microscopic world into orderly plan, is a strong hint to alter the plan. It means that we have been aiming at a false ideal of a complete description of the world. There has not yet been time to make a serious search for a new epistemology adapted to these conditions […] It seems more likely that we must be content to admit a mixture of the knowable and unknowable. (Eddington 228)

Eddington's higher-order disposition enabled him to see beyond physics. Inside exact science, his recognition of incompleteness finds a later analogue in Gödel's theorem, which "many consider the most important result of 20th century mathematics" (Hofstadter n. pag.). Outside exact science, his call for "a new epistemology" found responses in Bohr and Heisenberg, who developed philosophies from "complementarity" and "uncertainty" principles.

These philosopher-scientists are united in an overarching view that transcends tribalism and in their communication via a language akin to poetry. Einstein expressed the "strong reciprocal relationships and dependencies" of science and religion "by an image: science without religion is lame, religion without science is blind" ("Science and Religion" n. pag.). To illustrate the danger of "the belief in progress", Heisenberg crafted an allegory: "With the seemingly unlimited expansion of his material might, man stumbles into the position of a captain whose ship has been so securely built of steel and iron that his compass needle now points only to the ship's mass, no longer to the north". Yet, "the moment he recognises the situation, the danger is half removed" (Heisenberg, "Naturbild der Physik" [Natural Picture of Physics] 68, trans. HZ). Perhaps the pithiest of all is Eddington's metaphor of "a leaky bucket":

> A quantum action may be the means of revealing to us some fact about Nature, but simultaneously a fresh unknown is implanted in the womb of Time. An addition to knowledge is won at the expense of an addition to ignorance. It is hard to empty the well of Truth with a leaky bucket. (Eddington 229)

Taken together, these episodes establish a recurring epistemological pattern: moments of scientific rupture are accompanied by reflexive reconsiderations of method, language, and limits, often articulated through metaphor, analogy, and narrative rather than formal proof alone. It is this pattern – where conceptual innovation emerges alongside creative modes of expression – that provides the framework for the following analyses of Empson's and Enzensberger's poems.

Hubris and Doctrine: "The God Approached Dissolves into the Air"

Inspired by scientific revolutionaries, poets ventured into physics and mathematics with a penetrating gaze that would transform both literary production and interpretation. Empson is a quintessential example. After completing a mathematics degree at Cambridge in the 1920s, he embarked on the English Tripos while continuing his scientific voyage by absorbing the Rutherford lectures on quantum theory. In 1930, when his Cambridge fellow Paul Dirac "published the first full-length book in English on the subject", Empson reviewed *The Metaphysical Foundations of Modern Science*, discussing "relativity and how 'the view of space taken by modern physics will eventually alter our notion of reality'" (Bate 312-13). In the same year, 1930, Empson debuted with one of "the most justly famous works of literary criticism […] entitled *Seven Types of Ambiguity*":

> different types of ambiguity account for much of the richness and depth of literature […] Here we are close to what Keats […] called 'negative capability': […] when a man is capable of being in uncertainties, mysteries, doubts, without any irritable reaching after fact and reason. (McGilchrist 588–589)

Empson's eccentric path coincides with Gödel's. At the University of Vienna, Gödel shifted from theoretical physics to mathematical logic with a reverence for philosophy, which prompted him, at the age of 24, to dethrone authority and conformity, proving that "nearly a century of effort by the world's greatest mathematicians was doomed to failure" (Hofstadter n. pag.). At Cambridge, Empson switched from mathematics to English with a reverence for science, which enabled him, also at the age of 24, to derive knowledge from Eddington's lectures, producing "the literary-critical equivalent of quantum mechanics" (Bate 315).

Juxtaposing Empson with Einstein and Schrödinger, Jonathan Bate illustrates how Empson's reflexive observation, transdisciplinary translation, and creative interpretation of the new physics resulted in his seven types of ambiguity:

> Erwin Schrödinger demonstrated mathematically that a hydrogen atom may have two energies at once, something impossible under previous atomic theory; William Empson demonstrated critically that a text may have two contradictory meanings at once, something impossible under previous literary theory […].
>
> Empson is Modernism's Einstein among literary critics. His "both/and" is the twentieth century's most powerful contribution to the understanding of Shakespeare because it is both a microscopic and a macroscopic way of seeing. (Bate 315-16)

Empson's "own production of metaphysical poetry for the Einstein age" is also "founded on reading practices that treat the latest scientific problems and insights as having comparable cultural value to the literary canon" (Price 97). Thus, Empson's revolutionary leap occurred simultaneously in theory and practice. From his earliest publications in the *Experiment* magazine (1928-1931) to his collection *Poems* (1935), his poetry was so steeped in the then new physics that Empson, in his preface to *Collected Poems* (1955), lamented: "I have been much disturbed by recent theories that the universe is not, after all, finite though unbounded, as the earlier poems here often require it to be" (Empson 2).

"Finite but unbounded" occurs a dozen times in Eddington's Gifford Lectures. "Space is boundless by re-entrant form not by great extension. *That which is* is a shell floating in the infinitude of *that which is not*" (Eddington 83, italics in the original). This elaboration provides a meeting-ground for Einsteinian astrophysics, ancient Daoist and Greek philosophy, and modernist poetics. A poem is that which is – the worded, the named, the manifested. Its ambiguous implication is that which is not – the un-worded, the unnamed, the concealed. A floating poem can be momentarily captured in a frame for active observation. Different framings promise to recognise a poem's potential and actualise it by *re-entrant* form, as hinted at in Heraclitus' fragment – "on the circumference of a circle, the beginning and the end are in common" (163) – and in T.S. Eliot's "Little Gidding" (1942):

> We shall not cease from exploration
> And the end of all our exploring
> Will be to arrive where we started
> And know the place for the first time (Eliot 216).

Drawing upon the convergence of Eddington, Laozi, Heraclitus, and Eliot, I examine Empson's "Doctrinal Point" (1935) as a case study to show how a transreader – an attentive reader, transdisciplinary translator, creative interpreter, and transcultural critic – can realise a "finite but unbounded" poem:

> The god approached dissolves into the air.
>
> Magnolias, for instance, when in bud,
> Are right in doing anything they can think of;
> Free by predestination in the blood,
> Saved by their own sap, shed for themselves,
> Their texture can impose their architecture;
> Their sapient matter is already Informed.
>
> …
> They know no act that will not make them fair.
>
> Professor Eddington with the same insolence
> Called all physics one tautology;
> If you describe things with the right tensors
> All law becomes the fact that they can be described with them;
> This is the Assumption of the description.
> The duality of choice becomes the singularity of existence;
> The effort of virtue the unconsciousness of foreknowledge.
>
> …
> They have no other that they should compare.
> Their arch of promise the wide Heaviside layer
> They rise above a vault into the air. (Empson 39–40)

Eddington coined the word "wavicle" to convey how "the incongruous properties of wave and particle" are in fact "universally associated": "There are no pure waves and no pure particles" (Eddington 202). Adapting this concept for literary analysis and aligning it with Empson's logic of "both/and", this article treats *"Doctrinal Point"* as a web of interconnected wavicles. These function simultaneously as poetic particles – discrete verbal units that invite interpretation – and as poetic waves that shape the reader's movement through the poem. By tracing three such wavicles – "Professor Eddington", "Magnolias", and "The god" – the following analysis maps the poem's re-entrant form.

The wavicle "Professor Eddington" introduces the poem from a scientific perspective. References to "all physics" as "one tautology," to "the right tensors" as rendering all things describable, and to the capitalised "Assumption of the description" articulate a vision of scientific totalisation that implicitly marginalises religious explanation.

Within this framework, the "duality of choice" – applicable both to objects of inquiry and to the scientists who study them – is resolved into a "singularity of existence", shifting from indeterminacy toward determinacy and from plurality toward consistency. The resulting "effort of virtue" gives way to what the poem terms "the unconsciousness of foreknowledge", a state in which comparison is foreclosed: "They have no other that they should compare", and thus collapse into "one tautology". This re-entrant configuration recalls what Eddington described as the "Cyclic Method of Physics":

> the physical properties of matter and other entities are expressed by their linkages in the cycle. And you can see how by the ingenious device of the cycle physics secures for itself a self-contained domain for study with no loose ends projecting into the unknown. (Eddington 263-64)

This self-contained domain of certainty, determinacy, and consistency ultimately gives way to its opposite: "*Something unknown is doing we don't know what*" (Eddington 291). In light of the accumulation of unresolved conceptual and interpretive difficulties that accompanied the development of modern physics, Eddington's reflections on the "Nature of Exact Science" and the "Limitations of Physical Knowledge" can be read as an early articulation of concerns that would later become central to twentieth-century epistemology. Against this backdrop, "Doctrinal Point" alludes to the scientific doctrine critiqued by Eddington with "insolence" fully justified, adopting a deliberately provocative tone in order to expose the limits of claims to completeness and self-sufficiency.

The second *wavicle* "Magnolias" shifts the analytical focus. Attending to Empson's novel description of a timeless metaphor, the analysis identifies another instance of re-entrant form in the poem: "Functioning as their own saviours […] the magnolias represent a self-contained system that produces only beauty" (Price 105). Analogous to Eddington's diagnosis of closed explanatory systems in physics, the magnolias "know no act that will not make them fair", a formulation that eliminates contingency by collapsing action and outcome into a single evaluative loop. In this sense, the magnolias, like the scientific systems under critique, admit no external point of comparison and therefore reduce difference to repetition – what the poem terms "one tautology".

This logic is reinforced at the level of diction and syntax. Phrases such as "Their texture can impose their architecture; / Their sapient matter is always already informed" adopt a register closer to logical assertion than to lyric description, foregrounding self-sufficiency, necessity, and internal determination. The resulting effect recalls what Austrian philosopher Ludwig Wittgenstein, in the *Tractatus Logico-Philosophicus*, describes as the "logically exacting" structure of tautological systems, which "articulates a sophisticated version of the metaphysical theory of logical atomism" (Duignan n. pag.), in which propositions generate further propositions without reference to anything beyond the system itself:

> 6.1 The propositions of logic are tautologies.
> 6.126 We prove a logical proposition by creating it out of other logical propositions by applying in succession certain operations, which again generate tautologies out of the first. (And from a tautology only tautologies follow.)
> 6.22 The logic of the world which the propositions of logic show in tautologies, mathematics shows in equations. (Wittgenstein 76-82)

Read against Eddington's critique of the "Cyclic Method of Physics", this convergence situates "Doctrinal Point" within a broader reflection on closed systems of explanation. Empson's own commentary underscores this reading when he notes that the poem juxtaposes "the cope of heaven which protects the earth" with the "vaults over tombs under the ground from which the flowers have risen" (Empson 103), thereby aligning organic growth, architectural enclosure, and cosmological order within a single structural figure.

The poem's final line, "They rise above a vault into the air", returns to its opening image, "The god approached dissolves into the air", forming a lyric circle that mirrors both the self-enclosing architecture of the magnolias and the cyclic logic earlier identified in physical theory. In this respect, the poem does not merely echo scientific models of closure but renders their implications perceptible through form, preparing the ground for the subsequent critique of calculative abstraction articulated in Eddington's well-known example of the sliding elephant. Instancing "an elephant slides down a grassy hillside", Eddington illustrates how natural objects – the elephant, the hillside, and the sliding down – "must be replaced by quantities representing the results of physical measurement", i.e., two tons, 60˚, and "a functional relation of space and time measures" (Eddington 253):

> And so we see that the poetry fades out of the problem, and by the time the serious application of exact science begins we are left with only pointer readings. If then only pointer readings or their equivalents are put into the machine of scientific calculation, how can we grind out anything but pointer readings? (Eddington 252)

In light of "pointer readings" void of poetry, "Doctrinal Point" emerges as a bi-directional ramification of science. In one direction, the semi-divine beauty of magnolias revitalises the lifeless entities of exact science. In another direction, their autopoiesis exposes "the ingenious device of the cycle" by which physics secures itself, only to fall prey to the cycle's blind spots:

> Small wonder then that physical science should have evolved a conception of the world consisting of entities rigorously bound to one another by mathematical equations forming a deterministic scheme […] The determinism of the physical laws simply reflects the determinism of the method of inference. (Eddington 271)

Thus far the reading has co-created "Doctrinal Point" by actualising its potential via two wavicles, both of which turn "the end of all our exploring" into a rediscovery of "where we started" (Eliot 216). The poem's ultimate through line however, is concealed in its third wavicle, the "god" from "The god approached dissolves into the air".

With contradicting tenses alluding to the space-time continuum, this single-line stanza initiates the poem's lyric circle. Unlike the previous wavicles, which foreground structural or conceptual closure, this opening gesture adopts a more encompassing perspective, one in which Eddington's and Whitehead's opposite entrances converge. Through this opening, the reader can identify a third re-entrant form by which the poem integrates science, religion, and philosophy into a single interpretive *gestalt.* Considered both in its constituent parts (the poetic wavicles) and as a whole (the "finite but unbounded" poem), this configuration reframes the hubristic "Assumption of the description" into a humbling "Doctrinal Point". A theological analogue to this epistemic gesture can be found in a sermon on the Gospel of John by the late antique theologian Augustine of Hippo:

> *IN THE BEGINNING WAS THE WORD, AND THE WORD WAS WITH GOD, AND THE WORD WAS GOD*
>
> […] So everything that is in a place or space is less in its parts than in its totality. We must have no such ideas, no such thoughts about the Word. We must not form images of spiritual realities in materialistic terms. That Word, that God, is *not* less in his parts than in his totality.
>
> *Let us make a devout confession of ignorance, instead of a brash profession of knowledge*
>
> 5. But you are quite unable to imagine or think of such a thing. And such ignorance is more religious and devout than any presumption of knowledge. After all, we are talking about God […] so why be surprised if you cannot grasp it? I mean, if you can grasp it, it isn't God. (Augustine 209–11)

Augustine's sermon does more than illuminate the poem's opening line. It articulates a principle of epistemic restraint against which the poem's meta-Doctrinal Point becomes legible: a god that can be fully grasped is no god at all. This logic of ungraspability is not confined to Christian theology. The god "you can grasp […] isn't God" echoes not only the *Dao* at the beginning of the *Daodejing* – "The word [*Dao* as noun] that can be worded [*Dao* as verb] isn't the eternal word" (Laozi 1, trans. HZ), but also Heisenberg's "uncertainty relations": "two determinants of a system, which must both be known at once in classical physics, in order to determine the system completely, cannot, in quantum theory, be exactly known at the same moment" (Heisenberg, *Encounters with Einstein* 116).

Within twentieth-century physics, this shared insight was further elaborated through Bohr's notion of "complementarity", which Eddington synthesised with Heisenberg's work under the heading of "the principle of indeterminacy". As Eddington argued, increasing precision in one dimension of description necessarily entails loss of precision in another (Eddington 220-21). The point is not merely technical but epistemological: completeness, when pursued without qualification, generates its own limits:

> if we are content with statements that claim no certainty but only high probability, then it is possible to ascribe both position and velocity to a particle. But if we strive after a more accurate specification of position a very remarkable thing happens; the greater accuracy can be attained, but it is compensated by a greater inaccuracy in the specification of the velocity […] The conditions of our exploration of the secrets of Nature are such that the more we bring to light the secret of position the more the secret of velocity is hidden. (Eddington 220-21)

Read in this light, Empson's "god" may be provisionally translated into the modern scientific aspiration toward a unified theory – an aspiration that has repeatedly been accompanied by calls for intellectual humility. As Martin Gardner observed, "modern science should indeed arouse in all of us a humility before the immensity of the unexplored and a tolerance for crazy hypotheses" (n. pag.). What is at stake, then, is not the abandonment of ambition but the manner in which ambition is pursued.

This concern links modern science back to older traditions of epistemic self-restraint. Propertius' remark "And should strength fail me, my daring at least shall win me praise: in mighty projects even to have wished is enough" captures the ethical tension between daring and limitation (Propertius 133). It matters, however, *how* these daring attempts are made. Both modern science and Augustine call for "a devout confession of ignorance, instead of a brash profession of knowledge", not to mention "any presumption of knowledge".

Of Bohr, Einstein said: "He utters his opinions like one perpetually groping and never like one who believes he is in possession of definite truth" (Pais 1). Of those who know not enough to undergo what Einstein called "rapturous amazement", Bohr said: "they will not know their ignorance and will never wonder" (Quinn 219). In philosophical terms, this posture corresponds to what Nicolas of Cusa called *docta ignorantia* – the recognition that "the deeper we know our unknowing, the nearer we are to truth" (3). Nicolas himself embodied *docta ignorantia*: "steeped in the Neoplatonic tradition, well aware of both humanist and scholastic learning", Nicolas "anticipated many later ideas in mathematics, cosmology, astronomy and experimental science" (Miller n. pag.).

Transreading Empson's poem brings its central through line into focus: recognising the limits of knowledge – scientific and spiritual alike – creates the conditions for rethinking how such limits are understood. To acknowledge that one does not know, and may never fully know, while remaining open to the unknown and the unknowable, is not presented here as a resolution but as an interpretive stance sustained across the poem's wavicles. In this sense, the "Doctrinal Point" names the shared epistemic orientation around which otherwise divergent traditions converge.

Axioms and Intuitions: "'Mathematizing' May Well Be a Creative Activity […] like Language or Music"

By 1930, uncertainty and unknowability were widely regarded as obstacles to be overcome in mathematics rather than as productive conditions of inquiry. This orientation is captured in the opposition between the Latin maxim *ignoramus et ignorabimus* and its counter-formulation *no ignorabimus*, articulated most prominently by Emil du Bois-Reymond and David Hilbert. Examining their programmatic statements – here in English translation – brings into focus the differing assumptions about knowledge, proof, and solvability that shaped early twentieth-century debates on the foundations of mathematics.

In his 1872 address on "The Limits of Knowing Nature", Du Bois-Reymond coined the Latin maxim *ignoramus et ignorabimus*, i.e., *we do not know and we shall never know*, by differentiating between two types of riddles: "the riddles of the physical world" and "the riddle of what matter and force are and how they are able to think". Facing the former, the natural scientist "pronounces the verdict: *ignoramus*"; facing the latter, he "must once and for all be resigned to the tougher verdict: *ignorabimus*" (Du Bois-Reymond 464).

Hilbert however, coined the anti-maxim "no *ignorabimus*", i.e., no *we shall never know*, at two historic events: the 1900 International Congress of Mathematicians in Paris and the 1930 meeting of the Society of German Scientists and Physicians in Königsberg:

> This conviction of the solvability of each and every mathematical problem is a powerful incentive to working mathematicians; we hear within us the constant call: There lies the problem, seek the solution. You can find it by pure thinking; for in mathematics there is no *ignorabimus*! (Hilbert, "Mathematische Probleme" 262, trans. HZ).
>
> […] the mathematician shall not believe those who, with a philosophical countenance and a superior tone, prophesy today the decline of culture and

> rejoice themselves in *ignorabimus*. For the mathematician there is no *ignorabimus*, and, in my opinion, none whatever in natural science […] Contrary to the silly *ignorabimus* let our motto be:
>
> We must know,
> We shall know. (Hilbert, *Naturerkennen und Logik* 963, trans. HZ)

Hilbert's motto – later engraved on his tombstone as an epitaph – runs contrary to both Du Bois-Reymond's maxim and Nicolas' *docta ignorantia* shared by Einstein, Eddington, Bohr, and Heisenberg. Fighting for "We must know, We shall know", Hilbert led intensive research to propose "a program for a new foundation of mathematics. The program called for (i) a formalization of all of mathematics in an axiomatic system followed by (ii) a demonstration that this formalization is consistent" (Zach 920). By the time Hilbert reiterated "no *ignorabimus*" in 1930, he had built a 'paradise' for mathematicians, from which no one could drive them out – that is, until Gödel came along:

> In 1930, both Hilbert and the young mathematician Kurt Gödel were in Königsberg at the same time. Gödel was attending the Second Conference for Epistemology of the Exact Sciences on 5-7 September. The last day of the event was devoted to a roundtable discussion of the foundations of mathematics (only a day before Hilbert's famous speech to which Gödel had been invited) […] in November 1930, the Leipzig Journal *Monatshefte für Mathematik und Physik* received Gödel's twenty-five-page article "On Formally Undecidable Propositions in *Principia Mathematica* and Related Systems I". (Reichenberger 65-66)

A rebel from within, Gödel broke the closed system to expose Hilbert's "effort of virtue" as "the unconsciousness of foreknowledge", proving that

> there will always be individual propositions in the language that are undecidable by the system, that is, statements that can neither be proved nor disproved from the system axioms provided the system is consistent (first incompleteness theorem). Furthermore, Gödel showed that the consistency of such a system cannot be proved within the system itself (second incompleteness theorem). (Reichenberger 66)

Gödel's intervention marks a decisive shift in the debate: the question is no longer whether mathematics can secure certainty through axioms, but what kind of knowledge remains possible once formal completeness is shown to be unattainable. This shift reframes the opposition between axioms and intuitions as an epistemological problem rather than a technical one.

Even before Gödel "drew the conclusion that formal (syntactical) provability cannot be treated as an analysis of (semantical) truth" (Reichenberger 71), the Hungarian-American polymath John von Neumann confided in Gödel his own conclusion: "your result has solved negatively the foundational question: there is no rigorous justification for classical mathematics" (von Neumann 124). In 1931, von Neumann wrote to the German-American philosopher Rudolf Carnap:

> I am today of the opinion that
> (1) Gödel has shown the unrealizability of Hilbert's program.

> (2) There is no more reason to reject intuitionism […]
> Therefore I consider the state of the foundational discussion in Königsberg to be outdated, for Gödel's fundamental discoveries have brought the question to a completely different level. (von Neumann 85)

Von Neumann's remarks point in two directions. In the first, "a completely different level" hints at "metamathematics", a term used by Hilbert to refer to "the study of rigorous proof in mathematics and symbolic logic" (Braithwaite 2), but which had previously referred to "a meta-discipline, reflecting on the general epistemological conditions of mathematical reasoning and the ontological status of mathematical objects and relations". (Reichenberger 60)

In the second direction, von Neumann's revaluation of "intuitionism" hints at Hilbert's motive to develop his programme, namely, to resist the 1920s "calls for a 'revolution' in mathematics by the intuitionist Brouwer and his own student Hermann Weyl" (Zach 920). Reaching across disciplines like Eddington and von Neumann, Weyl "embodied a living contact between the main lines of advance in pure mathematics and in theoretical physics" (Dyson 457). Upon Hilbert's death in 1943, Weyl paired Gödel's approach with Brouwer's to relativise Hilbert's "entire enterprise" resulting from his "attempts to save the holdings of mathematics in their entirety by proving its formalism free of contradiction":

> While Brouwer has made clear to us to what extent the intuitively certain falls short of the mathematically provable, Gödel shows conversely to what extent the intuitively certain goes beyond what (in an arbitrary but fixed formalism) is capable of mathematical proof […] "Mathematizing" may well be a creative activity of man, like language or music, of primary originality, whose historical decisions defy complete objective rationalization. (Weyl, "David Hilbert" 392)

The consequences of this reframing extend beyond mathematics. They generate a series of resonances that unfold along two distinct but intersecting trajectories: one concerned with creativity and mechanism, the other with truth, consistency, and formal abstraction.

The first surrounds Weyl's idea that the creativity of mathematicians binds them to poets and musicians while distinguishing them from machines. This idea echoes Gödel's own interpretation of his theorems: "It is not possible to mechanise mathematical reasoning, i.e., it will never be possible to replace the mathematician with a machine" (Gödel 164). Their view resonates with "Minds, Machines and Gödel" (1959) by the English philosopher J.R. Lucas: "There is no arbitrary bound to scientific enquiry: but no scientific enquiry can ever exhaust the infinite variety of the human mind" (Lucas 127). Such arguments against mechanism resonate further with the English mathematician Roger Penrose, who won the 2020 Nobel Prize in Physics. In a conversation with the American cosmologist Brian Keating on "artificial intelligence, consciousness, cosmology, and the many fascinating developments in physics since the publication of *The Emperor's New Mind* in 1989", Penrose recalled the moment he was stunned by Gödel's proof: "Whatever procedure you use, if it is following definite rules which you believe in – that algorithm you trust – then you can see how to transcend it" (Penrose/Keating).

At the 1953 lecture series on "The Arts in the Age of Technology" in Munich, Heisenberg reframed a Daoist parable to illustrate the consequences of mechanism, creating the most astonishing resonance with Weyl and Gödel in the first circle.

Embedded in "Heaven and Earth" in the *Zhuangzi*, the parable features a gardener who declined the offer of an efficient draw-well by a disciple of Confucius:

> When a man uses a machine, he carries on all his business like a machine. He who carries on his business like a machine, attains the heart of a machine. When he has a machine heart, pure simplicity is lost. He who loses pure simplicity, becomes restless in the impulses of the spirit. Restlessness in the impulses of the spirit is that which is incompatible with the *Dao*. Not that I do not know such machines; I am ashamed to use them. (Zhuangzi 136, trans. HZ)

After citing the gardener faithfully from Richard Wilhelm's German translation, Heisenberg omitted the moral and appropriated the Daoist critique of Confucius for a transdisciplinary symposium including such fellow speakers as the philosopher Martin Heidegger, the poet Friedrich Jünger, the illustrator Emil Preetorius, and the musicologist Walter Riezler. Arguing that "'Restlessness in the impulses of the spirit' is perhaps one of the aptest descriptions we can give to the human condition in the present crisis", Heisenberg delivered a transcultural interpretation of "the grave truth embedded in this ancient tale" by "the Chinese wiseman Zhuangzi who spoke of the peril to man of using machines two and a half thousand years ago" (Heisenberg, "Naturbild der Physik" 57-59, trans. HZ). This "grave truth" functions as a cautionary figure rather than a moral injunction, foregrounding the risk that technical ingenuity may outpace reflective understanding – a concern that remains structurally relevant in contemporary debates surrounding artificial intelligence.

The second circle of resonances surrounds Weyl's observation that Hilbert's programme shifted "the question of truth" into "the question of consistency" (Weyl, "David Hilbert" 391). This observation echoes Einstein's critique of the noncontradiction "achieved by axiomatics", which evokes Eddington's critique of the "Cyclic Method of Physics" that informed Empson's "Doctrinal Point":

> as far as the propositions of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality […] The progress achieved by axiomatics consists in its having neatly separated the logical-formal from its objective or intuitive content; according to axiomatics the logical-formal alone forms the subject matter of mathematics, which is not concerned with the intuitive or other content associated with the logical-formal. (Einstein, *Collected Papers* 233)

"This view of axioms", Einstein continued, "purges mathematics of all extraneous elements, and thus dispels the mystic obscurity which formerly surrounded the basis of mathematics" (Einstein, *Collected Papers* 234). Einstein conveyed his observation to the Prussian Academy of Sciences in 1921, one decade before Gödel "turned the lens of mathematics on itself […] driving a stake through the heart of formalism" (Hofstadter n. pag.), and two decades before the two began their daily "excursions to the edge of thought", as portrayed in *When Einstein Walked with Gödel.*

It is at this point that the implications of the axioms-intuitions debate re-enter literature explicitly. Enzensberger's reflections provide a literary response to the epistemological tensions exposed by Gödel, Weyl, and Heisenberg. In 2002 (collected edition *Elixirs of Science*, 2004), the German poet Enzensberger penned an essay, "The Poetry of Science", noting Gödel's impact on the return of "the mystic obscurity", which Einstein saw expelled from mathematics:

> In cosmology and neuroscience, speculative ideas that do not allow for immediate experimental verification are no longer taboo. Since Gödel, even mathematicians have been grappling with the ambiguity of their cognitive possibilities. In quantum physics, the unthinkable is mundane. (Enzensberger, *Elixiere der Wissenschaft* [Elixirs of Science] 273, trans. HZ)

Just as Eddington and Empson encounter on the common ground of science and poetry, Enzensberger meets Heisenberg as another transepochal reader, transdisciplinary translator, and transcultural critic:

> At the risk of offending "hard" defenders of the status quo, one dare claim that the most advanced science has become a contemporary form of myth. Unnoticed by most scientists, as if behind the back of their own ideology, all the primal questions, dreams, and nightmares of humanity return in their conceptions, shaping a new whole. (Enzensberger, *Elixiere der Wissenschaft* 273-74, trans. HZ)

With "The Poetry of Science", Enzensberger saluted modernity's journey home to antiquity in Greece, India, Mesopotamia, Egypt, and China, where "religion, philosophy, science, and poetry were inseparable", unified by "their common roots: myth" (Enzensberger, *Elixiere der Wissenschaft* 262-63, trans. HZ).

Enzensberger's essay adopts its motto, "Mathematics is a poetry of ideas", from the Swiss mathematician Armand Borel. Its final line, "poetry is even there at work, where no one suspects her" (Enzensberger, *Elixiere der Wissenschaft* 274, trans. HZ), alludes to two poet-mathematicians. The first is von Neumann who, in Enzensberger's view, "operates with unbridled operators" to hunt "*elegant solutions, which shall make the planet dance*" (Enzensberger, *Elixiere der Wissenschaft* 43, trans. HZ, italics in the original). The second is Gödel who, in Enzensberger's observation, proved "the boundary of self-knowledge" and "the darkness of reason". To illustrate the latter, Enzensberger invoked Oskar Kokoschka's painting that inspired Georg Trakl's poem "The Night": "The Bride of the Wind, her hair as dark as reason" (Enzensberger, *Ordnung der Dinge* [Order of Things] n. pag., trans. HZ).

Against the backdrop of the tempests in the history of modern mathematics, Enzensberger's approaches were "side-glances": he watched the intense drama surrounding axioms and intuitions "from the coulisse, not from the parquet". This "different gaze" enabled him to "see everything differently" and "decipher certain gestures and motions" that he transfused into literature (Enzensberger, *Ordnung der Dinge* n. pag., trans. HZ).

Taken together, these developments show how the tension between axioms and intuitions migrates from mathematics into broader cultural reflection, preparing the ground for Enzensberger's poetic engagement with Gödel in the section that follows.

Uncertainty and Consistency: "Noncontradiction Is a Revelation of Incompleteness"

"Side-glances" is both the subtitle and the throughline of Enzensberger's anthology, *Elixirs of Science* (2004). Its ending, "The Poetry of Science", takes the reader back to its beginning, "Homage to Gödel". A reprint of Enzensberger's 1971 poem informed by Gödel's 1930 thesis, this "homage" is a representative 'elixir of science'. In parallel with Empson who borrowed Eddington from physics to advance English poetry and poetics, Enzensberger borrowed Gödel from mathematics to enhance German literature and philosophy.

Translating "Homage to Gödel" from German into English demands participatory observation of its aesthetic, rhetoric, and conceptual subtleties, bringing into focus the poem's effort to align complementary perspectives across mathematics, philosophy, and literature.

> Münchhausen's theorem, horse, mire, and hair,
> is enchanting, but remember:
> Münchhausen was a liar.
>
> Gödel's theorem, at first glance, seems
> obscure, but consider:
> Gödel is truthful.
>
> "In every sufficiently complex system,
> statements can be made,
> which cannot be proven or disproven
> within the system,
> unless the system
> is itself inconsistent."
>
> You can describe your own language
> in your own language:
> but not entirely.
> You can explore your own brain
> with your own brain:
> but not entirely.
> And so on.
>
> In order to vindicate itself,
> every conceivable system
> must transcend itself,
> i.e., raze itself.
>
> "Sufficiently complex" or not:
> Noncontradiction
> is a revelation of incompleteness
> or a contradiction.
>
> (Certainty = Inconsistency.)
> (Enzensberger, *Elixiere der Wissenschaft* 9–10, trans. HZ)

Like Empson's "Doctrinal Point", "Homage to Gödel" can be read as a web of interconnected wavicles: they are *both* poetic particles that draw the reader into the poem *and* poetic waves that guide the reader through its interwoven themes. By tracing four such wavicles, the following analysis brings into focus the interdependence of poetic and scientific thinking articulated in the poem.

The most conspicuous wavicle – "Certainty = Inconsistency" (stanza 7) – condenses the poem's engagement with formal self-reference into a single, provocative equation. Framed by Enzensberger's juxtaposition of Münchhausen's self-vindication with Gödel's theorem, the line foregrounds a paradox internal to systems that seek complete self-description: the stronger the claim to certainty, the more fragile the consistency of the system becomes. Read in this context, the equation resonates with a series of five scientific theses addressing the limits of formal completeness from different angles. First, Einstein's critique of the "progress achieved by axiomatics" articulates the dilemma at stake: "as far as the propositions of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality" (Einstein, *Collected Papers* 233). Second, Weyl's assessment of the inconsistency inherent to certainty sharpened this insight: "While Brouwer has made clear to us to what extent the intuitively certain falls short of the mathematically provable, Gödel shows conversely to what extent the intuitively certain goes beyond what […] is capable of mathematical proof" (Weyl, "David Hilbert" 392). The poem's insistence that a system must "transcend itself" in order to "vindicate itself" echoes similar constraints in twentieth-century physics. Thus, third, Heisenberg's "uncertainty relations" show that complete determination within a system is unattainable when mutually dependent variables are involved: "two determinants of a system, which must both be known at once in classical physics, in order to determine the system completely, cannot, in quantum theory, be exactly known at the same moment" (Heisenberg, *Encounters with Einstein* 116). Fourth, Bohr extended this insight by arguing that the renunciation of strict causality was precisely what secured the internal consistency of quantum mechanics: the "renunciation of a strictly causal description" led to "the reciprocal uncertainty relations set up by Heisenberg and applied by him as the basis of a thorough investigation of the logical consistency of quantum mechanics" (Bohr, *Quantum Physics I* 248). Fifth, Eddington generalised the principle further; concluding that "knowledge of one-half of the world will ensure ignorance of the other half" (Eddington 308). Against this backdrop, Enzensberger's formulation "Noncontradiction / is a revelation of incompleteness" can be read as a poetic articulation of a shared epistemological limit: systems that preserve consistency do so at the cost of completeness, whereas claims to total certainty entail internal contradiction. The poem's closing equation thus functions as a lyrical compression of a constraint that mathematics and physics had already encountered in formal terms.

The second wavicle is the building up of a leitmotif: self-sacrifice as self-transcendence. Mimicking the mathematician's voice, stanza 3 condenses Gödel's thesis into one sentence, turning a scientific revolution into a quoted proverb. Springing from this foundation, stanza 4 illustrates the resonances of Gödel's proof in linguistics, neuroscience, "And so on". This transdisciplinary spiral attains its zenith in stanza 5, "every conceivable system / must transcend itself", only to plunge into the abyss upon the final verdict: "i.e., raze itself".

This dramatisation of Gödel's thesis conceals a tragic moment: a mathematical "cathedral of awe-inspiring height and seductive beauty" (Enzensberger, *Ordnung der Dinge,* n. pag., trans. HZ) has been razed to the ground. Yet, even the tallest cathedral is finite, and so must be sacrificed for the sake of the infinite. As Weyl remarked in 1932: "*mathematics is the science of the infinite*, its goal the symbolic comprehension of the infinite with human, that is, finite means" (Weyl, "The Open World" 38, italics in the original). A leitmotif of Daoism (Perdue/Zhang), self-sacrifice as self-transcendence finds an early echo in "Blissful Longing", Goethe's 1819 poem in *West-östlicher Divan*:

> And so long as you have it not,
> This: Die and become!
> You are but a mournful guest
> Upon the dark planet (Goethe 22, trans. HZ).

The third wavicle is the striking analogy between Gödel and Münchhausen, an 18th-century taleteller. Münchhausen's "enchanting" claim appeared in Nietzsche's critique of the *causa sui*, i.e., the unconditioned, in *Beyond Good and Evil* (1886):

> The *causa sui* is the best self-contradiction hitherto imagined […] the desire to bear the whole and sole responsibility for one's actions and to absolve God, world, ancestors, chance, society from responsibility for them, is nothing less than the desire to be precisely that *causa sui* and, with more than Münchhausen temerity, to pull oneself into existence out of the swamp of nothingness by one's own hair (Nietzsche 51).

Nietzsche's observation evokes Eddington's and Empson's critique of the hubristic "Assumption of the description" in physics. In "Homage to Gödel", the *causa sui* recurs as "Münchhausen's theorem" in contrast to "Gödel's theorem" (stanzas 1-2). Choosing the past tense for Münchhausen and the present tense for Gödel, Enzensberger let the mathematician expose the famous spinner of tall tales as "a liar" who belonged to the past.

This contrast brings into focus a recurrent tension in the history of science. Figures engaged in foundational work repeatedly confront two opposing imperatives. On the one hand, they seek to construct and defend closed systems of consistency and completeness, thereby asserting autonomy and unconditioned independence. On the other hand, they are compelled to question these systems from within, responding to external pressures and internal doubts in order to pursue forms of interdependence that connect previously separated domains and forces.

Hilbert, e.g., said of infinity in 1926: "Instead of the old principle *natura non facit saltus* [nature does not make jumps], one might even assert the opposite, viz, 'nature makes jumps'". He considered the role of the infinite to be an idea "which transcends all experience and which completes the concrete as a totality" (Hilbert, "On the Infinite" 185, 201). Conversely, Einstein in 1927 "would not admit that it was impossible, even in principle, to discover all the partial facts needed for the complete description of a physical process". His refusal provoked a "friendly admonition" by the physicist Paul Ehrenfest: "Einstein, I am ashamed of you; you are arguing against the new quantum theory just as your opponents argue about relativity theory" (Heisenberg, *Encounters with Einstein* 80). Towards the end of his life, however, when asked if he had any regrets, Einstein replied: "I wish I had read more of the mystics earlier in my life'" (Fox 1).

The fourth wavicle that illuminates the symbiosis between science and poetry is the assertion "Noncontradiction is a revelation of incompleteness" (stanza 6). Unadorned and uncompromising, this assertion bridges the quoted proverb that encapsulates Gödel's theorem (stanza 3) and the parenthesised equation that evokes five scientific theses (stanza 7). In this assertion, from a mathematical perspective

Einstein's and Weyl's argument against the noncontradiction achieved by axiomatics can be detected. Simultaneously, from the perspective of literary and cultural criticism, Empson's and Enzensberger's advocacy of the broad-minded "both/and" against the narrow-minded "either/or" can be identified.

Taken one step further, the assertion admits a mirrored formulation – *completeness is conditioned and fulfilled by contradictions* – which aligns the poem with both Bohr and Heisenberg who heightened their interpretations of quantum mechanics into widely applicable philosophies. "The question whether from a complete knowledge of the past we can predict the future, does not arise", said Heisenberg, "because a complete knowledge of the past involves a self-contradiction" (Eddington 228–29). The "notion of *complementarity*" derived from evidence "which appears contradictory" yet "exhausts all conceivable knowledge about the object", said Bohr, presents "in epistemological respects far-reaching similarities" (Bohr, *Essays* 4-6). His Coat of Arms for the Order of the Elephant – a Danish royal honour – displays a Latin motto over a *Taiji* symbol (Figure 1), manifesting "complementarity" in three aspects.

In the first aspect, Bohr's motto *contraria sunt complementa*, i.e., *opposites are complements*, illustrates what he calls "deep truth", in which "the opposite also contains deep truth" and which "inspires the imagination to search for a firmer hold" (Bohr, *Atomic Physics* 66). In the classical tradition, "deep truth" evokes both Nicolas' *coincidentia oppositorum*, i.e., *coincidence of opposites*, and Heraclitus' fragment D47: "Conjoinings: wholes and not wholes, converging and diverging, harmonious dissonant; and out of all things one, and out of one all things" (Heraclitus 161). Heisenberg, too, placed modern physics "extremely near to the doctrines of Heraclitus". In his view, Heraclitus reconciled "the idea of one fundamental principle with the infinite variety of phenomena" by recognising that "'the opposite tension' of the opposites […] constitutes the unity of the One" (Heisenberg, *Physics and Philosophy* 60-61).

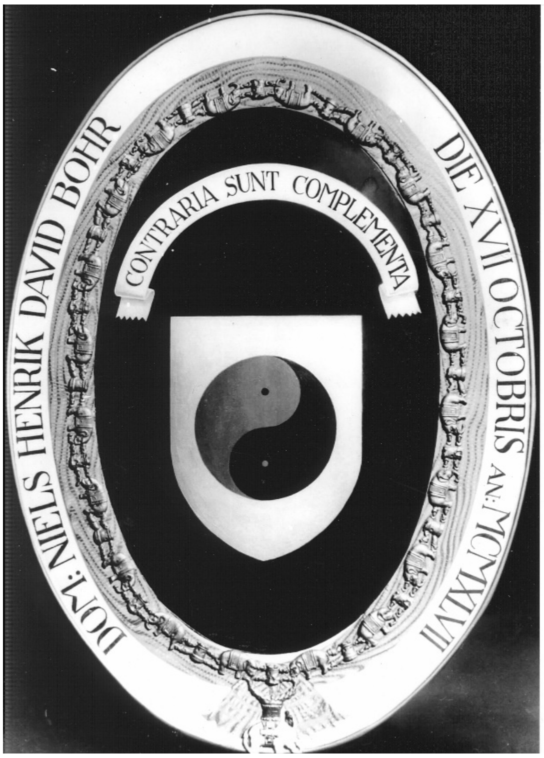

Figure 1 Courtesy of Niels Bohr Archive

In the second aspect, the *Taiji* symbol visualises the never-ending interplay of *yin* and *yang*. The attainment of Daoist completeness through the interpenetration of opposites resonates with Bohr, Heisenberg, Nicolas, and Heraclitus. D47 finds echoes in both chapter 2 of the *Daodejing* and "Heaven and Earth" in the *Zhuangzi*, where Heisenberg detected the "grave truth" and adapted it for his critique of mechanism:

> Being and non-being beget each other
> Heavy and light offset each other
> Long and short define each other
> High and low entail each other

> Music and song fulfil each other
> Before and after precede each other
> (Laozi 2, trans. HZ)
>
> Harmonising the dissonant is called "generosity"
> Transcending barriers and distinctions is called "liberality"
> Possessing innumerable contradictions is called "prosperity"
> (Zhuangzi 130, trans. HZ)

In the third aspect, Bohr's coat of arms combines the Latin motto that *articulates* complementarity with the Daoist diagram that *illustrates* complementarity, exhibiting the complementarity of language and icon, the *worded* and the *unworded*. In recontextualising the Dao, Bohr demonstrates how completeness, in epistemological terms, can only be achieved by accommodating rather than eliminating contradiction.

Conclusion: Transreading and the Reflexivity of (Non-)Knowledge

This final section draws together the article's central figures by focusing on a shared transformation of observation itself – from detached description to reflexive, participatory engagement.

All curious minds discussed in this article have expanded our conception of observation, albeit in different ways: Einstein's embrace of "unobservable quantities" inspired Heisenberg to formulate "uncertainty relations". Gödel's self-referential gaze penetrated "the wide Heaviside layer" of Hilbert's program. Bohr's reframing fused "the richness of physical experience" with "the mystery that remains". Eddington's higher-order vision enriched the hermeneutic repertoire with "wavicles", "re-entrant form", and "finite but unbounded" space. Empson's "seven types of ambiguity" contributed to literature and science "both a microscopic and a macroscopic way of seeing". Enzensberger's side-glances rediscovered the poetry of mathematics and the "common roots" of science and the humanities. Taken together, these contributions displace observation from a position of external mastery toward one of relational involvement.

The primacy of interdependent relations and the creativity of reflexive observation are central to this shift. Heisenberg proposed a participatory universe, where science "no longer stands aside as an onlooker, but recognizes itself as part of the interplay of man and nature". Not only do scientists turn "the network of relations and connections" into "the object of thinking and acting", but their observational "grasp" also "transforms its object" (Heisenberg, "Naturbild der Physik" 67, trans. HZ).

Meanwhile, Bohr unfolded the complementarity of spectator and actor throughout seven public lectures, spanning the 1928 speech at the 25th anniversary reunion of his high school graduating class and the 1960 address "The Unity of Human Knowledge". Bohr's engagement with this problem did not remain confined to physics. The 1937 lecture "Biology and Atomic Physics", delivered four months after his China tour, invokes Laozi emphatically: "For a parallel to the lesson of atomic theory […] we must in fact turn to quite other branches of science, such as psychology, or even to that kind of epistemological problems with which already thinkers like BUDDHA and LAO TSE have been confronted, when trying to harmonize our position as spectators and actors in the great drama of existence" (Bohr, *Complementarity* 60). The genealogy of this citation reaches back to distinctive Danish recreations of Daoist thought.[2]

Bohr’s interest in “epistemological problems” and his attention to Eastern traditions converge at an ancient resonance in *Sarva-upanishat-sâra*, a secondary writing which, based on the older Upanishads, enumerates and explains the primary concepts of the Vedânta system: “He who observes the subject, the object, and the activity of observation in their emergence and recession, while he himself neither emerges nor recedes, but is himself light, he is called ‘the Spectator’ (*sâkshin*)” (Veda-Upanishads 626, trans. HZ).

This conception of observation as light rather than position reappears, strikingly, in modern literature. The Upanishadic conception of observation finds an astonishing echo in a 1918 journal entry by Franz Kafka who, like Bohr and Heisenberg, studied Daoist classics (see Zhang, “A Perfect Bliss-Potential Realized: Transreading ‘Wish, to Become Indian’ in Light of Kafka’s Dao”, and “Cracking ‘a Hard Nut’: How Kafka and Hauge Transread *Laozi*”): “Living means being in the centre of life: seeing life with the eye, by whose light I have created it” (Kafka 38, trans. HZ). The image of the “light” of the creative eye offers a concise figure for the kind of reflexive engagement that transreading seeks to cultivate.

By extending close reading into participatory observation, translating concepts across disciplinary boundaries, situating individual works within constellations of complementary perspectives, and attending to the creative dimension of interpretation, this article has outlined transreading as an integrative methodological practice. Rather than treating literature, science, and philosophy as separate domains, transreading foregrounds the reflexive processes through which knowledge is produced, limited, and reconfigured.

Across the analyses presented here, physicists, mathematicians, and poets confront analogous epistemological constraints. Their work demonstrates that observation is never fully external to its object and that formal consistency is often achieved at the expense of completeness. Read together, these scientific and literary engagements reveal recurring strategies for negotiating uncertainty, self-reference, and contradiction. The contribution of transreading, as proposed here, lies not in resolving these tensions but in making them analytically productive.

By tracing how different disciplines articulate and respond to the limits of knowledge, transreading offers a framework for comparative inquiry that remains sensitive to disciplinary and genre specificity while enabling meaningful dialogue across fields as diverse as science, philosophy, and poetry. In this respect, the analyses converge on a shared insight: both the most rigorous theorem and the most elusive metaphor operate within formal bounds that simultaneously delimit and enable meaning. Each is finite, yet unbounded.

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Notes

1. The term "transreading" originates in *Reading Rilke: Reflections on the Problems of Translation* by William Gass (New York: Alfred A. Knopf, 1999). I thank Christopher Higgins for introducing me to the term during the National Endowment for the Humanities workshop, "The Centrality of Translation to the Humanities: New Interdisciplinary Scholarship" (University of Illinois at Urbana-Champaign, USA, 2013). I have since elaborated on this concept and developed it into a method in my publications (see list of works cited).

2. My investigation into archival troves and rare correspondences reveals that Bohr's Laozi reference sprang not from the Chinese original but from works by Danish transreaders. In a 1958 letter, Bohr thanked Svend Hugo Jürgensen for his manuscript comparing modern physics to the *Daodejing* – a clue that rekindled Bohr's early fascination with Laozi, first awakened by Ernst Møller's *Old Master* (1909) and later deepened during his 1937 China tour. By remapping the spectator-actor duality into quantum complementarity, Bohr bridged philosophy, poetry, and physics in a way that only a thinker of his calibre could achieve. In this light, the citation that once seemed a century-old riddle now resonates as a layered chord, composed across languages and cultures (Zhang, "The Fourth 'Vinegar-Taster': Denmark's Quantum Pioneer Transreads Confucius, Laozi, and Zhuangzi").

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