Published in *Angelaki,* Vol. 25 (5), 10 Sep 2020, doi: [10.1080/0969725X.2020.1807132](https://doi-org.proxy.library.emory.edu/10.1080/0969725X.2020.1807132)

**Other Matters: Karen Barad’s Two Materialisms and the Science of Undecidability**

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**ABSTRACT**

Karen Barad’s *Meeting the Universe Halfway* relies on mutually incompatible grounding gestures, one of which describes the relationality of an always already material-discursive reality, while the other seeks to ground this relation one-sidedly in matter. These two materialisms derive from the gesture she borrows from the New Materialist (and other related) fields, which posits her work as an advance over the history of “representationalism” and “social constructivism.” In turn, this one-sided materialism produces a skewed reading of the quantum mechanical phenomena with which she engages. Her attempt to create an ontological (not epistemological) interpretation of quantum mechanics proves deconstructible. Instead, a science of undecidability or science of *quant à* helps us to understand debates among scientists and philosophers over the completeness or incompleteness of quantum mechanics and its epistemological or ontological status – by demonstrating that these questions will necessarily remain unresolved.

Can science surprise itself? Can it be surprised? That it does not rest on its own presuppositions, as did and do faith-based discourses, but leaves itself open to experience, to the experiment that could each time shake its expectations, is a founding principle of science, at least in its modern form. But Kant taught us that the one thing experience alone can never provide itself with, or be provided with, is the one thing science seeks, the principle, the law. Experience, if there is any, provides particular things, and no amount of particular things could even suggest the idea of universality and necessity implied in a principle, unless such an idea had been put there already. Which would mean that science always and everywhere encountered the same, itself. At least, the novel entities it encounters that re-orient its laws, and the “empirical” laws it constructs (which are reoriented by those novel entities), can only be discovered on the basis of some profound, unchanging ground. Alteration can only be perceived on the basis of permanence; for two things to differ, they must be the same. Kant offered one version of this foundation, the laws for the possibility of experience, an experience of a unitary world by a unitary subject. Some of his conclusions were undermined by the “revolutions” of the past two centuries of scientific thought, but his fundamental insight is valid; these revolutions can only reveal a more fundamental glimpse of their shared basis with the previous scientific moment. At least, that is all they can do if they are to remain revolutions *of science*. Would it be possible, for example, for a science to discover that its nomothetic form was no longer valid or optimal? That neither nature nor thought would conform to a system of hierarchized and internally consistent laws, or even that the idea of law itself was invalid, that no ideality repeated in such a way to allow for the reproducibility of experimental evidence? If such premises are unchallengeable, unfalsifiable, what would have to happen, what event or miracle would need to take place for a science of novelty to emerge, for us to experience the singular as singular, unencumbered by any presupposition? It would be necessary to think science otherwise to encounter this unknown, which could never be assimilated as yet one more discovery in the progress of knowledge.

 The fundamental position of Karen Barad’s work is that quantum mechanics reveals for the first time a science of infinite alterity, opens science to this radical other. Her agential realism is developed from Niels Bohr’s complementarity principle, an attempt by one of the founders of quantum mechanics to account for the mutual exclusivity and yet the mutual necessity of characteristics of quantum phenomena such as wave-particle duality or position-momentum indeterminacy. In Barad’s summary, Bohr explains this not as a surpassable uncertainty but as a dependence of the measured trait on the measuring device—there is no object with properties existing independently of the apparatus that could measure them, and it would be impossible to create an apparatus that could register one without obfuscating the other. On the basis of this interpretation, Barad develops her doctrine that there are no relata before relations—the fundamental constituents of reality are “phenomena” that stand in no causal relationship to an underlying object or noumena. Out of the “intra-action” of these phenomena, a measured object and measuring instrument emerge, neither of which can be said to precede their relationship or exist independently of it. On the one hand, Barad’s doctrine produces a differential account of reality; against the “classical” or Newtonian-Cartesian framework, agential realism describes a reality whose most fundamental level is “ethico-onto-epistem-ological” and “material-discursive,” a fundamental entanglement out of which knower and known, words and things come to be separated. On the other hand, she repeatedly invokes one-sided formulations that celebrate the agency of matter and insist on the ontological, not epistemological, status of agential realism—formulations that her doctrine should forbid.

 One of the most fundamental thetic statements of agential realism, published as the essay “Posthumanist Performativity” before it was expanded into the fourth chapter of Barad’s *Meeting the Universe Halfway*, poses her intervention as a reversal, rather than an entanglement or undecidability, of the language/matter hierarchy, “In my agential realist elaboration of Bohr’s account, *apparatuses are the material conditions of possibility and impossibility of mattering*; they enact what matters and what is excluded from mattering” (Barad, *Meeting* 148; author's emphasis).[[1]](#endnote-1) Alongside such statements in her work, one will always find countervailing assertions such as, for example, “material apparatuses produce material phenomena through specific causal intra-actions, *where ‘material’ is always already material-discursive*—that is what it means to matter” (Barad, *Meeting* 153; my emphasis). How is one to arbitrate between these dual tendencies, which alternate between arguing that matter is always co-constituted by its other and that it precedes and governs its others as a self-contained whole? Indeed, the reception of her work straddles this divide. While Sara Ahmed has criticized Barad for a one-sided materialism that reinforces traditional binaries by celebrating matter as a “pure theoretical object” (35), the OOO crowd has criticized Barad for precisely the opposite; positing relationality as fundamental in a way that bars access to matter or objects in themselves (Bryant; Harman). Of course, it is possible to find proponents of her work who take it up on the basis of either or both of these conflicting theses as well (Andersson). Despite or because of this ambiguity, her work has had considerable influence well beyond its native gender studies and science studies fields, where it also continues to inspire new engagements (Selberg and Hinton). Given that Barad’s methodology has been received as coherent and taken up in the fields of rhetoric (Gamble and Hanan), pedagogy (Postma), organizational studies (Carlile), and theoretical psychology (Shotter)—to name a few—it is worth returning to the source to better understand the impetus of this influence. Perhaps the alibi offered by its juxtaposition of conflicting doctrines (materialism and a philosophy of difference) is its very appeal.

In short, Barad’s relationality allows for an intersectional critique of science and its practices that has long been the domain of Feminist Science and Technology Studies, while her materialism adheres to the scientism of the New Materialist moment, without reflecting on the necessary contradiction of these positions.

 This tension has its root in the (anti-)correlationist form she gives to her project as a whole. She frames agential realism in opposition to “representationalism,” which she defines in terms common to the New Materialist field, “Indeed, the representationalist belief in the power of words to mirror preexisting phenomena is the metaphysical substrate that supports social constructivist, as well as traditional realist, beliefs, perpetuating the endless recycling of untenable oppositions” (Barad, “Posthumanist Performativity” 802). Casting the past few decades of philosophy and theory as “social constructivism” that privileged culture over nature and the human over matter has been the founding gesture of New Materialism. The symptoms of such an intellectual corralling, which suppresses the differences within the past and present in order to celebrate its own futurity, can be observed in any discourse defining itself or its moment by periodizing markers such as the posthuman or the Anthropocene, and in other self-styled schools of thought premised on these exclusions, such as Speculative Realism. Given that the accusation of correlationism does little to diagnose the work it attempts to corral, but fundamentally dictates the form of the discourses in which it appears, it will be more useful to have a term to designate the latter; I will use *corralationist*.

Ahmed is correct in all the criticisms she raises of this gesture’s intellectual merit; it effaces the differences among and within past texts, carries on a debate with an invented opponent (“social constructivism”) in order to purely separate itself from the past, and so forces itself into one-sided position taking that can only reinforce the traditional binaries it claims to critique. Noela Davis, objecting to Ahmed in “New Materialism and Feminism’s Anti-Biologism,” counters that New Materialist authors do not claim that the past said culture where they will say nature, but that the past sought to separate what now shows itself to be inextricable: nature-culture. She cites Barad as an example. Of course, one will find evidence for both Ahmed’s and Davis’s claims in Barad’s work.[[2]](#endnote-2) In truth, neither of these corralational denegations can take place without the suppression of some difference (in the past and in oneself), though this one-sidedness is most apparent when Barad is insisting on primordial materiality. She makes the entanglement of matter and meaning belong originally to matter itself, as a sovereign self-identity without outside: “Matter is not immutable or passive. Nor is it a fixed support, location, referent, or source of sustainability for discourse. *It does not require the mark of an external force like culture or history to complete it.* Matter is always already an ongoing historicity” (Barad, *Meeting* 151; my emphasis).[[3]](#endnote-3) Taking a side, in this way, is useful if one would ground a movement and secure one’s own identity.

A careful reading of Barad’s work will show that the other strand of her thought, which insists on an originary entanglement of matter and meaning, is no less plagued by a dogmatic one-sidedness. Against “representationalism,” which imagines language-culture-thought to be outside of and mirroring matter and nature, Barad defines her thought as a “performativity” that recognizes both series as constituted out of a single praxis. Such oppositional definition, which posits her discourse as a self-identity free of any relationship to “representationalism,” ought to be forbidden by agential realism itself. One senses the problem all the more when one realizes that the representationalist doctrine is precisely the thesis that many authors typically placed in the “social constructivist” corral critiqued or deconstructed (anyone identifiable as structuralist or poststructuralist, for example). One indication of how much more complicated things become when one deals with actual texts, when one reads, is that the proper names brought forward every time Barad invokes social constructivism, Foucault and Butler, are cited as *both* *critics and exemplars* of its imagined representationalism.[[4]](#endnote-4) If any text and any reading is always already on both sides of such binary opposition, then any effort to periodize past and present will find itself compromised by what it attempts to hold at a distance. In Barad’s case, the binaries she sets up to keep her performativity free of representationalism and to separate her agential realism from any contamination by the “classical” worldview will be the very aspect of her thought that mires it in the traditional conceptuality she hopes to surpass.[[5]](#endnote-5)

One word for what this corralational thinking excludes or suppresses is deconstruction, a practice of reading that finds the other already at work or in play in the same. Barad frames deconstruction as the equation of being and language in *Meeting the Universe Halfway:*

Moving to what some consider the opposite pole of the traditional realist position are the semiotic and deconstructionist positions. To many scientists as well as science studies scholars, the theories of semiotics and deconstruction, which call into question the assumed congruity of signifier and signified, insisting on the intrinsic arbitrariness of the sign or representation, seem to be the ultimate in linguistic narcissism (42).

Deconstruction is not a theory, nor a doctrine that could be the basis for an -ism, and it is certainly not the theory or doctrine of the arbitrariness of the sign. This structuralist thesis was a target of some of Derrida’s earliest deconstructions (see, for example, *Glas*, right column, pp. 104–12). Structuralism was a criticism of what Barad would call a representationalist account of language – it argued that language could not receive its meanings from an extralinguistic world, because that world was shaped by the differential meanings encoded within language. While this led certain of its followers to something like what Barad calls “linguistic narcissism,” which implies that language is a self-contained whole, Derrida argued that if there is no pure outside of language, language’s agency and identity are as unstable as those of its others. It is no more possible to say whether we are inside or outside language, whether it shapes the world or the world shapes it. If it makes “traditional realists” uneasy to be unable to identify the outside of language, it is no less impossible to identify the outside of reality/materiality/nature/etc.[[6]](#endnote-6) One cannot make deconstruction fit within the binaries of representationalism, nor those of any other debate that takes place as this and other corralationist writings do, by positioning doctrines and schools of thought on either side of traditional binaries. Neither the past texts and authors that end up on the bad side of the corralation, nor the scientific phenomena represented by Barad as constituting the good side, can comfortably occupy their side of the binary without setting in motion or being displaced by some deconstruction.

*Quant à*

 Barad’s reading of quantum mechanical experiments and their conceptualizations, which forms the basis of her agential realism, demonstrates the tension between originary difference and the search for sufficient ground in her work. The basic phenomenon from which she begins is the double-slit experiment.[[7]](#endnote-7) A series of electrons (for example) passing through a barrier with two openings will arrive at different locations on a measurement device set up to record their position some distance from the barrier. The probabilistic aspect of this movement is its least astonishing characteristic. Even if the electrons pass through the apparatus one by one, they will form an interference pattern on the measurement device, as though they were waves crashing against each other after passing through the slits (the measurement device will show a distribution of higher and lower concentrations of electrons, like a ripple effect of peaks and troughs). Each individual measurement seems to show a particle, which could in principle only pass through one of the two slits, but they spread out as though they were waves passing through both. What’s more, some physicists have put forward experimental apparatuses that they claim measure the path the electron takes (which slit it passes through), without imparting any transfer of momentum to the electron—in these cases, the interference pattern (the ripple effect) disappears. It is as though our measurement, merely by making the electron’s particle-like behavior cognizable, eliminates any trace of its wave-like behavior.

Barad’s preferred interpretation of these results attempts to do away (up to a point) with the idea of a particle or wave with definite position or momentum existing prior to the measurement, and merely being disturbed by the act of measurement. Rather, she posits as fundamental the relationship of the quantum with a measuring apparatus. Only within a “phenomenon” that includes this relationship does anything come to exist or have definable properties, and the object and measuring instrument that can be separated out from the phenomenon emerge from its “intra-action.” In the example of the double-slit experiment, because the measurements of position and momentum require mutually exclusive experimental set-ups, these properties belong to different phenomena and will only manifest when the appropriate experimental arrangement is present. Barad puts forward some compelling and quite fascinating experimental evidence to support her claim, including experiments in which the very presence of a measuring device able to distinguish certain properties of the quantum seems to produce a different experimental outcome, as she would say, a different phenomenon.

 Conceptually, Barad frames this account in terms of the dual, incompatible trends of her thought. On the one hand, the phenomenon is the non-grounding ground of a philosophy of relationality, in which ontology and epistemology should never be separated, but rather understood as an onto-epistemological entanglement:

The separation of epistemology from ontology is a reverberation of a metaphysics that assumes an inherent difference between human and nonhuman, subject and object, mind and body, matter and discourse. Onto-epistem-ology—the study of practices of knowing in being—is probably a better way to think about the kind of understandings that we need to come to terms with how specific intra-actions matter (Barad, *Meeting* 185).

On the other hand, she labors throughout *Meeting the Universe Halfway* to prove that Bohr’s theory is *ontological* where Schrödinger and Heisenberg were *epistemological*, and ultimately claims her own theory is the only truly ontological one, surpassing even the epistemological remnants of Bohr’s.

I would argue that the undecidability of ontology and epistemology, being and thinking, is the proper way to understand any science, and something that comes to the fore in a peculiar way in quantum mechanics. Whether its laws are complete or incomplete and whether they accurately reflect reality have been a source of debate among scientists and theorists since its inception. The impossibility of definitively answering these questions is generalizable—though not for the reason that some uncertainty or indeterminism present at the quantum scale extends to other aspects of our cognition. Rather, we should focus on what these results, and the process of their formation, show us about the conditions of possibility of science, which reveal something about the conditions of possibility of knowledge and experience in general.[[8]](#endnote-8) It is the conditions of possibility of science that prove to be also the conditions of its impossibility; we can make sense of our experience in the first place only on the basis of our efforts to make experience conform to the laws that separate subject and object, substance and accident, cause and effect—we only have something that can count as an experience to the extent that it has been, even without our knowing it, structured according to such laws in advance. The many points in history at which concepts thought to be foundational were transformed serve as exemplary reminders that we never know such laws to be absolute. There is no experience without these structuring presuppositions, yet we know these presuppositions are contingent, revisable. Then, even or especially when a new experience seems to insist on a new legal framework, it will be and will have been impossible to say what part of the phenomenon belonged to our contingent legislation and what part belonged to nature itself, if there is such a thing. It will be and will have been as impossible beforehand, on the basis of the now outmoded legislation, as it will be after the fact, when a new legal framework attempts to sort subject from object, epistemology from ontology. Such a deconstruction of science undercuts none of its methodology or accomplishments; in fact, it is only on the basis of such deconstruction that what we consider to be its greatest advances have been possible—and, understood in this way, the process of dissensus by which the scientific invention or discovery of the new comes about, as well as the considerable pathos accompanying such revelation, can be predicted to continue indefinitely.[[9]](#endnote-9)

This fundamental undecidability of ontology and epistemology, were it what Barad meant by referring to “phenomena,” would be a true insight into the nature and foundations of science. In this sense, we could say the quanta are, each and every one, *quant à,* only what they are with respect to or reference to some other. Barad, on the other hand, does not treat these binaries as undecidable, or not exclusively. She frequently insists that her own project be understood as an ontological, not an epistemological one.[[10]](#endnote-10) She first celebrates Bohr’s complementarity principle as an ontological advance over what she claims are the too epistemological interpretations of Heisenberg and Schrödinger, then claims that Bohr is too epistemological, and her own agential realism is an ontological advance over complementarity. This chain of argumentation alone is enough to suggest that epistemology/ontology is here, as everywhere, deconstructible.

Barad’s first claim is that Heisenberg’s uncertainty principle is epistemic in the sense that it suggests an electron (for example) has definite position/momentum properties, but that these are unknowable by any observer because the act of measurement disturbs them. She prefers an “ontic” indeterminacy principle, which posits not an ignorance of the observer but an indefiniteness belonging to the object itself (Barad, *Meeting* 261). It is not clear that such a distinction between ontology and epistemology can be secured. We could look in the work of Heisenberg and Schrödinger, the “epistemological” interpreters, for indications that they too ontologize, within certain limits, the notion of indeterminacy. Or rather, that whether anything like indeterminacy can belong entirely to being or thought is undecidable, both in their work and in that of Bohr and Barad.[[11]](#endnote-11) We can also look in the work of Bohr and Barad to find the places where they must epistemologize in order to construct their doctrines. Not to catch them in a contradiction, but to show that the one-sided positing of a ground depends in a compromising way on what it excludes.

 Barad herself makes this argument with respect to Bohr. She ties Bohr’s epistemologism and humanism to his insistence that “classical concepts” are necessary for the objective validity of quantum mechanical measurements. This assertion responds to the need created by complementarity’s introduction of the act of measurement into that measurement’s results. How, if the act of measurement creates the phenomenon it describes, can the result of a given measurement be said to have the objective, repeatable validity constitutive of scientific explanation? This conceptual problem exists in conflict with the apparent fact that quantum measurements give reproducible results. However unfamiliar the nature of the object described by the mathematical formalization, its predictive success suggests some sort of viewer- or even apparatus-independence.

 How does Bohr’s complementarity principle explain this validity? Barad practices a bit of kettle logic in answering this question. On the one hand, she argues against interpreters of Bohr who claim that there is something humanist or epistemological in his invocation of classical concepts or terms to account for objectification, as though he would limit the validity of quantum mechanical description to human observers or the laboratory setting. Barad’s counterclaim is that Bohr in fact posits a material ground for conceptual determination, and thus an objectification with universal validity (we will consider, in a moment, how this conflicts both with her desire for a relational philosophy and with logic in general). In other words, concepts are indeterminate in themselves, as are objects, but both gain definition through the intervention of an apparatus Barad repeatedly insists is material in itself, and which defines the conditions for the concept to have meaning. Position is only a definite concept if we can devise an apparatus capable of measuring it, and the same goes for momentum, time, (and presumably justice, beauty), etc.

 On the other hand, Barad retains the claim that there is something epistemological and humanist in Bohr’s work, and that her agential realism offers the step beyond it to a purely ontological, posthumanist theory, “The notion of agential separability strengthens Bohr’s notion of objectivity from the intersubjective human-based criteria of reproducible and unambiguous communication to a more general ontological criterion, founded, like Einstein’s notion of objectivity, on a condition of separability” (*Meeting* 339). It seems here that her desire to discover her doctrine in a unique reading of Bohr comes into conflict with her desire to invent a new theory herself. Her attribution of the material determination of concepts to Bohr would remove the grounds on which the claims of humanism and epistemology are made against him—and Barad offers no other evidence before maintaining these claims (Barad, *Meeting* 330–331). Ignoring for a moment her auto-critique, we should question this equation of language and concept with the human and the epistemological. First of all, the “classical concepts” Bohr tells us are necessary for the interpretation of quantum measurements would be least dependent of all on a human observer.[[12]](#endnote-12) That is not to say that there is no humanism in Bohr—any number of passages could be brought forward, for example from “The Unity of Human Knowledge,” to reveal it. I would object only to the idea that this humanism can be distributed across the ontological/epistemological binary in the manner Barad suggests. If the assumption is being made that the human, thinking, language, and epistemology all belong to one side of a binary chain that opposes them to ontology, being, and matter, such a formulation is only possible on the basis of the most traditional, metaphysical, and precisely humanist definitions of language, etc. Barad’s account seems designed to protect matter and the ontological from any contamination by the human, in order to more easily open the space for her “posthumanist” intervention.

 Whether we attribute it to Bohr or Barad, is Barad’s account of purely ontological, reproducible objectification (taking place through a material apparatus) consistent with her theory and with the scientific practices she is describing?[[13]](#endnote-13) We can say with some certainty that if the experimental result was ultimately grounded in the very material of the apparatus, in the manner suggested by Barad, all science would be impossible. What is matter, besides the each-time-particular? If we find groupings of matter to have similarities, that they behave in the “same” way under the “same” circumstances and are thus of the “same” material, what can these similarities or identities be but formal? Clearly the matter must be different or there would be no separation across which to recognize this identity. The properties and behaviors one recognizes in matter as the “same” can only be abstractions from its particular materiality.[[14]](#endnote-14)

 Nor does the relational strain of Barad’s thinking make it any easier to overcome this difficulty. If we take the privileged example of the double-slit experiment, can we in fact arrive at the quantum mechanical formalization if we hypothesize as ground a relational phenomenon out of which a “Bohrian cut” between object and apparatus comes to be made? If it were the case that there was nothing prior to the object-apparatus phenomenon, then there would be no reason and no grounds to relate the different but “complementary” wave-particle or position-momentum phenomena foundational for our concept of the quanta. In fact, the reason quantum mechanics poses a scandal for reason in the first place is that it seeks to ground these “complementary” phenomena in a single substance (thus something existing prior to the phenomenon), for example, the electron. If we did not posit the “same” substance underlying both heterogeneous phenomena, there would be nothing particularly radical about our observations. Two different phenomena would present two different behaviors.

 A truly relational theory would have to suspend the entire conceptual framework undergirding scientific investigation, including the Principle of Sufficient Reason, which holds sway over Barad’s thought and presents an index of what remains classical there.[[15]](#endnote-15) In its most well-known formulation, this principle asserts that for everything that exists, there is a sufficient cause why it exists, and for everything that is true, there is a sufficient reason why it is true. It is, in many ways the principle of principles, and the philosophical principle par excellence, because it grounds the very impetus or desire to place all things under a principle. It is foundational to the notion of internal consistency grounding systemic thought (all the principles of a discourse must be grounded and groundable in higher principles), and thus is the principle of all science, whose nomothetic form compels its search for ever higher principles. As we can observe in Barad’s work, there is something unitary implied in the idea of cause that makes it work against the relational-differential strand of her thinking. On the one hand, despite her assertion that the material-discursive phenomenon is an ontological primitive with no object existing prior to it as its cause, she frequently attributes the “production” of phenomena to a material apparatus, an agential cut, or simply “the world,” all of which must, therefore, precede it.[[16]](#endnote-16)

 One of Barad’s shorthand descriptions of agential realism—“relations without pre-existing relata”—can be understood as an attempt to suspend the Principle of Sufficient Reason (*Meeting* 333). If a ground was posited behind such a relation, one would end up with a quite traditional ontological picture, of substances supporting the observed predicates and coming into a cause-effect relationship. In order to insist that her interpretation of quantum mechanics is ontological, not epistemological, and in order to insist on the causal agency of matter, one can predict that Barad will have to re-assert the Principle of Sufficient Reason in a manner that undercuts relationality. Recall her criticism of Heisenberg’s uncertainty principle, which she called “epistemic” because it assumes electrons have definite position and momentum of which we are merely ignorant. The “ontic” principle she attributes to Bohr argues that there are no determinate properties apart from the interaction with a measuring device, “properties are only determinate given the existence of particular material arrangements that give definition to the corresponding concept in question” (Barad, *Meeting* 261). In order to make this assertion, it is necessary to know something about the properties or the substances, i.e. the relata, outside of any measurement or any relationship. For example, “our inability to predict […] is not due to our ignorance […] but rather because the values themselves are indeterminate before their measurement” (Barad, *Meeting* 265). Such a claim assumes some knowledge about the state prior to measurement and its connection (the enduring of substance, the succession of causes) to what emerges from the measurement.

 To understand this point, it is perhaps necessary to introduce a distinction between the “before” of a measurement, and the “beyond” of measurement and of knowledge. It is a trivial thing, in most fields of physics, to perform a measurement and reverse the temporal dimension of our equations to describe properties and states of the measured object prior to measurement. Though wave collapse seems to problematize this temporal continuity, there are quantum mechanical measurements for which this reversibility holds true as well (cf. “protective measurements” Gao 6–8). There is a deeper level of alterity, though, which is not what exists *before* measurement, but what exists *beyond* the partition of reality by our measurement and our knowledge.[[17]](#endnote-17) The before-measurement takes not only its definite value from the laws that make sense of our observations, but the fundamental structure of its substances, the time and space in which they interact, etc. Nothing can guarantee that the beyond-measurement obeys these laws. The revision or revolution of these laws changes not only our theories but the substances we attribute to nature itself (Kuhn 99–103). It is entirely possible, taking history as our guide, that a day will come when a debate about the wave/particle duality of the quantum will seem as relevant as an 18th-century debate about the true nature of phlogiston. The argument that has vexed Einstein, Bohr, Schrödinger, and others since the invention of the theory of quantum mechanics, the argument over the theory’s completeness or incompleteness, can on these grounds be answered a priori in the negative.

This does not mean that the quest for a theory’s completion or the question of its relationship to reality cannot motivate the most productive and revelatory research.[[18]](#endnote-18) In the latter case (the relation to reality), it is a matter of deriving testable hypotheses from a given representation. For Barad’s notion of indeterminacy, however, it is unclear what hypothesis, if any, one could derive from the idea that there is no determinate object or property existing outside of its measurement.[[19]](#endnote-19) The attempt to hinge this absolutely undefinable something with scientific theory and measurement is an attempt to suture the beyond-measurement to measurement.[[20]](#endnote-20) We will see, as we approach our conclusion, how this conflicts with the possibility of science.

This ontologizing, making what we do not know into what is not, produces or is produced by a hybrid that is better understood by means of a science of the *quant à,* of undecidability. Barad’s wrestling with the ontic or epistemic character of complementarity and uncertainty demonstrates this well. In fact, her theory straddles Bohr’s interpretation and one that necessarily departs from it; for Bohr, if an electron appears now as a wave, now as a particle, the reason these phenomena cannot appear simultaneously is that they are only determinate in the presence of a proper measuring device, *and the measuring device for one property effaces the other*. As I mentioned above (note 11), Bohr’s criticism of Heisenberg was not that the latter described uncertainty as resulting from a mechanical disturbance, but that the type of mechanical disturbance Heisenberg described could be calculated precisely (thus could not account for uncertainty). Similarly, when Bohr argued with Einstein over the double-slit experiment, his argument was not simply that different apparatuses would produce different phenomena, but that the device hypothesized by Einstein would produce a mechanical effect that erased the traces of wave-like behavior as it measured particle-like behavior (Bohr, *Atomic Physics* 46). In Bohr’s formulation, complementarity and uncertainty (if understood as ontic vs. epistemic) are indistinguishable at this point.[[21]](#endnote-21) In the purer sense Barad gives to it, complementarity could only be proven if an apparatus produced no mechanical disturbance whatsoever yet still changed the outcome of a measurement—such a result is a) difficult to verify, especially once we have accepted the possibility of non-local action and b) difficult to attribute to the *material* of the apparatus, as Barad would like. If the device produces no disturbance, it seems as though the very idea of particle and wave are coming into conflict.

The experiments Barad designates as proof of this strong version of complementarity demonstrate the undecidability of ontic and epistemic. Her preferred example of such an experimental apparatus is the modification of a double-slit experiment designed by Scully, Englert, & Walther (SEW), in which cavities placed before either slit capture a photon from the passing atom without disturbing its spatial wave function. The photon remaining in the cavity shows which slit the atom passed through, and, seemingly just by recording this information causes the wave-like interference pattern to disappear. SEW interpret their experiment as demonstrating the interweaving of complementarity (without any disturbance), but this conclusion has proven controversial (Barad considers this debate in Appendix C of *Meeting the Universe Halfway*, one sign that this question lingered for her). Wiseman et al. take the position that SEW’s results can be explained by a nonlocal momentum transfer, the sort of action-at-a-distance characteristic of entanglement; they view the result as another instance of the uncertainty principle “enforcing” complementarity. Barad views the role entanglement plays here as enough to prove her theory, but in truth it only muddies the waters, making it more difficult to rule out a mechanical disturbance (given that one can be delivered from a distance).

If we understand this experiment as I believe Barad would like us to, it still does not help us evade the undecidability of ontology and epistemology. Following Barad, the quantum would have to become something else, particle-like, without undergoing any mechanical disturbance. Especially in this case, it becomes impossible for us to attribute the experimental results to a *material apparatus* as Barad attempts to do. In fact, the influence of the measuring apparatus must be in a certain sense nugatory in order to rule out the mechanical disturbance interpretation (the one Barad sees as purely epistemic). Thus, the distinguishability of the two paths available to the atom does not depend solely on the apparatus, but equally on the observing act of the experimenter.[[22]](#endnote-22) Who or what makes a measurement? For whom or for what must these paths be distinguishable in order for the interaction to count as measurement and for the measured to become entangled with it? Perhaps, one day, practicing scientists or some group of them will reach a consensus on how to interpret this particular set of experiments, but the *quant à* will remain.[[23]](#endnote-23)

I do not wish to argue against a relational (or, perhaps, *differential*) thinking, but to place in question the dogmatic impulse for grounding that I see as ultimately a more prevalent trend in Barad’s study, and much New Materialist work. It would not be possible to say that matter (or a “material apparatus” or “material phenomenon”) was a grounding cause or basic ontological unit in a relational account where one could never say with certainty where matter begins and its others (form, idea, discourse, etc.) end. It would not be possible to say whether such a relationality (and its determinacy or indeterminacy) was ontological or epistemological, because one would never know what part of the phenomenon belonged to the scientific framework with which we scaffold experience, and what, if anything, came from beyond. It is only this difference that makes science possible, even if it also guarantees the impossibility of science’s ultimate goals (a coherent system of thought, a unitary theory of everything).[[24]](#endnote-24) Without the difference of particular and universal, a science grounded in the particular and relationality as Barad envisions it would resemble the mental capacities of Jorge Luis Borges’ “Funes, the Memorious.” The perfection of Funes’ memory guarantees his recording of every detail of every scene he witnesses, and so fractures existence into an objectless relationality: “Funes, we must not forget, was virtually incapable of general, platonic ideas. Not only was it difficult for him to see that the generic symbol ‘dog’ took in all the dissimilar individuals of all shapes and sizes, it irritated him that the ‘dog’ of three-fourteen in the afternoon, seen in profile, should be indicated by the same noun as the dog of three-fifteen, seen frontally. His own face in the mirror, his own hands, surprised him every time he saw them” (Borges, “Funes” 136). His “rhapsodic” “garbage heap” of a memory makes clear the unacknowledged role that abstraction plays every time Barad celebrates the materiality of the apparatus, “I suspect, nevertheless, that he was not very good at thinking. To think is to ignore (or forget) differences, to generalize, to abstract. In the teeming world of Ireneo Funes there was nothing but particulars—and they were virtually *immediate* particulars” (Borges, “Funes” 137). What one gives up, ultimately, is the substance that Barad so frequently posits underlying and uniting all her phenomena. She often describes phenomena as the world intra-acting with itself, a restoration of the unity of time and space that her theory ought to proscribe. Here too we should take a lesson from Borges, “We must go even further, and suspect that there is no universe in the organic, unifying sense of that ambitious word” (“John Wilkins” 231).

 Ironically, here and in all New or Two Materialist work, the effort to respect nature by recognizing its creativity, indeterminacy, and difference-from-self ultimately requires the most extreme exaggeration of the knowledge of the human subject. By banishing the possibility of an “epistemological” uncertainty, Barad is pretending that we know already what belongs to our thought and what to matter or nature (not as the objects of our laws but in themselves), and thus is absolutizing a given moment of scientific inquiry. By taking the “matter” of this given historical moment to be an absolute ground, what brings forth knowledge of itself by itself, she is eliminating the possibility of what we call, perhaps a bit hastily, scientific progress. And if we understand this nature or this matter to be something fundamentally incomplete, to be able to bring forth its own difference and thus to understand itself differently, it remains unclear why we feel confident referring to this protean non-self-identity as “matter.” This is not to claim that idea, form, or thought are better words for difference. Rather, should the greatest transformation reveal itself tomorrow, we will never have finished sorting out what piece of our previous science was corrupt ideology and what part touched on a kernel of being, nor will we have sorted the new phenomenon into being and thinking until we have brought it under a law and a paradigm. A partition that will remain only until that new law is transgressed by a further error of anticipation. And so what we have always known as science will continue, according to a movement or a rhythm one could quite aptly call deconstruction, and which is at its most potent and creative when it is understood as a science of undecidability.

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1. The “phenomena,” which Barad describes as the “basic units of existence” (Barad, *Meeting* 333), are supposed to pre-exist any subject-object divide and entangle the relations of what will later be sorted out as a material object in its intra-actions with a measuring apparatus. Nonetheless, she frequently makes reference to “material phenomena” as a contrast class to “discursive practices” (Barad, *Meeting* 34, 45, 66, 146, 151, etc.). It should not be possible to designate a phenomenon as material or distinguish it from something discursive, unless the presupposition has been made that we know what matter is already and that it precedes any relationship to discursivity. Barad goes on to ground the discursive in the material, “The shift I propose from linguistic concepts to *discursive practices (which are specific material practices)* places the emphasis on the dynamics of material practices” (334; my emphasis).

When an “electron” interacts with a measuring apparatus, for example, how are we to establish what is material, independent of our preconceptions, from what is sorted out after the fact by means of the application of scientific hypothesis and formula, by discursive construction? It is forever undecidable, especially when one considers how frequently the constructions of science are transformed, what belongs to either category. Which is not, by any means, to say that discourse or culture is fundamental. [↑](#endnote-ref-1)
2. A similar dogmatism or one-sidedness can be identified in all of the authors who Davis would like to exempt from Ahmed’s criticism. For this reason, I offer this reading of Barad not as an individual critique but a testing of the hypothesis that any work invoking a corralation to justify its own novelty will arrive at similarly arbitrary suppressions of the differences inside and outside itself. [↑](#endnote-ref-2)
3. Barad attributes these ideas to Butler but endorses them herself. [↑](#endnote-ref-3)
4. Barad acknowledges, whenever she discusses the pairing of Foucault and Butler, that they set out to challenge representationalism (refusing to posit matter or nature as a ground prior to some inscription), but concludes that they deny matter’s agency by making it a product of cultural forces. For example, “For all of Foucault’s emphasis on the political anatomy of disciplinary power, he fails to offer an account of the body’s historicity in which its *very materiality* plays an active role in the workings of power. This implicit re-inscription of matter’s passivity is a mark of extant elements of representationalism that haunt his largely postrepresentationalist account” (Barad, 65; my emphasis). The problem of invoking the “very materiality” of the body (Barad invokes an almost identical phrase, “the very matter of bodies” in objecting to Butler’s account of materialization [64]) is that precisely in a “postrepresentationalist” account in which matter is always “material-discursive,” one should never know exactly where the “very matter” lies, or one should know in advance that one can never find matter itself or in itself. How can one refer to the “very atoms” of a body without an account of where the body begins and ends that is necessarily entangled in discursivity (Barad, *Meeting* 66)? This refrain of the “very” is an appeal to a material substance outside discourse, a “representationalist” gesture. [↑](#endnote-ref-4)
5. A careful reading of her account of the brittlestar in ch. 8 of *Meeting the Universe Halfway* would show that in order to make experience something matter can have of itself, Barad must separate it entirely from a thinking substance she reserves for humans or at least animals with brains. For a reading of Barad’s brittlestar that makes its humanism and logocentrism apparent (without finding them problematic) see Joseph Rouse’s “The Conceptual and Ethical Normativity of Intra-active Phenomena.”

Žižek poses the question of how this humanist or cerebralist subject emerges from an agential realist account in the fourteenth chapter of *Less than Nothing,* “The Ontology of Quantum Physics” (948–949) As is customary of his thinking and of any thinking whose fundamental gesture is reversal, he responds both by making the empirical absolute and the absolute empirical. The difference between agential realism and representationalism is posited both as a “transcendental a priori” by Zizek and, in the language of immanentism, as “the very movement of constitution of the One” (Žižek 949). The symptoms of his transcendentalism are his maintenance of ultimately classical distinctions such as that between quantum phenomena and “ordinary reality,” or an animal sex without sexuality defined by “bodily content” and a “human sexuality” which affects activities described as having “nothing to do with sexuality” (Žižek 960). On the other hand, his immanentism results in the facile equation of categories such as the nothing of quantum physics with the Void or non-All “in-itself” (Žižek 925). [↑](#endnote-ref-5)
6. Clayton Crockett’s claim that Derrida wrote about “linguistic” *différance*, and can be suitably supplemented by Barad and other New Materialists’ theories of physical or materialist *différance* is based on a similar misreading (137–38). Barad’s valuation of deconstruction has changed since writing *Meeting the Universe Halfway*. See “On Touching—The Inhuman that Therefore I Am” and “Quantum Entanglements and Hauntological Relations of Inheritance.” [↑](#endnote-ref-6)
7. For Barad’s account of this and related experiments, see chs. 3 and 7 of *Meeting the Universe Halfway*. [↑](#endnote-ref-7)
8. Barad would also like to generalize the conclusions of quantum mechanics, finding entanglements and indeterminacies at work in the formation of, for example, economic praxis. She adopts the more (so-to-speak) physical method of generalization of these principles, suggesting that these conclusions should be drawn at least in part because quantum mechanics is valid across 25 orders of magnitude (Barad, *Meeting* 110). Such extrapolations would only be legitimate if one could derive and calculate economics (for example) from the principal equations of quantum mechanics. I would argue that considering the conditions of possibility of such knowledge provides more valid grounds for generalization. For other objections to Barad’s leveling of scale, see *The New Politics of Materialism*, chs. 8, 9, and 10. [↑](#endnote-ref-8)
9. This description of the inextricability of being and thinking within science (or, within nature) shares a close resemblance to Thomas Kuhn’s notion of paradigm in *The Structure of Scientific Revolutions*. On the one hand, Kuhn does maintain the idea and language of a nature existing outside scientific practice against which it is verified: “The decision to reject one paradigm is always simultaneously the decision to accept another, and the judgment leading to that decision involves the comparison of both paradigms with nature and with each other” (Kuhn 78). On the other hand, he ultimately demonstrates that paradigm shifts require or perhaps *are* transformations of nature and the world itself, “Nevertheless, paradigm changes do cause scientists to see the world of their research-engagement differently. In so far as their only recourse to that world is through what they see and do, we may want to say that after a revolution scientists are responding to a different world” (Kuhn 111). This is not to suggest that there is no “nature” in the sense of something outside the willful legislation of the scientist; rather, it is to place that nature at the greatest remove from our constructions, in order to preserve its alterity. [↑](#endnote-ref-9)
10. Woolgar and Lezaun cite Barad’s work in the course of a criticism of the turn to ontology in New Materialist studies more broadly (325–326). They rightly tie the impetus toward ontology to her effort to discover agential and causal primacy in matter. They suggest a reversal, seeing what counts as matter as the contingent outcome of scientific practices, which, of course, is also one of Barad’s theses. Instead of reversing the ontology/epistemology and matter/thought binaries, we should consider what happens to our notions of scientific practice and matter if it is impossible to say where one ends and the other begins. [↑](#endnote-ref-10)
11. For example, in the paper where Heisenberg defines his famous uncertainty principle, one finds several invocations of the necessity of experimentability for the definition of concepts, e.g., “If we want to clearly understand what is meant by the word ‘position of the object’—for instance, an electron—(relative to a given reference system), then we must indicate the definite experiments by means of which we intend to determine the ‘position of the electron.’ Otherwise the word is meaningless” (“Actual Content” 4). Such a formulation sounds quite similar to the relational view Barad equates with complementarity. Barad would likely respond that the difference lies in whether this experimentability is thought to disturb a preexisting property or to co-constitute the property’s origin. In this connection, it is worth pointing out that Bohr’s complementarity also describes how an experimental apparatus effaces (or doesn’t) a given property. Bohr’s response to Heisenberg, for example, is not that the electron has no position or momentum to be disturbed, but that a disturbance such as the one described by Heisenberg could be exactly calculated (and so could not be the ground of a position/momentum uncertainty). “Indeed, a discontinuous change of energy and momentum during observation could not prevent us from ascribing accurate values to the space-time co-ordinates, as well as to the momentum-energy components before and after the process” (Bohr, “Quantum Postulate” 583). [↑](#endnote-ref-11)
12. Bohr compares Einstein’s relativity theory and his own complementarity to classical mechanics on these grounds, “the decisive point is that in neither case does the appropriate widening of our conceptual framework imply any appeal to the observing subject, which would hinder unambiguous communication of experience” (*Essays* 7). In fact, Bohr’s account is not that objectification, being tied to classical concepts/terminology, is thereby dependent on humanity, but that precisely the transhumanism of physical investigation is owed to language. [↑](#endnote-ref-12)
13. Trevor Pinch offers an insightful critique of how Barad’s view of reproducibility avoids grappling with any of the difficulties STS scholars have raised with the concept and assumes a natural, immediate status for what should be presented as (in Barad’s terms) entangled, “Once it is realized that repeatable experiments themselves come from a culture of trust, a shared form of life and shared practices, including tacit knowledge, learnt and passed on in communities of practice, then the orientation is focused once more on humans” (Pinch 439). By focusing on the conceptual presuppositions (an unacknowledged hylomorphism) of what Pinch pictures according to a sort of contract theory as an empirical intersubjective consensus, I hope to show that there are factors circumscribing any such agreement that are not necessarily human in their origin, though they cannot therefore be attributed to ontology, nature, or matter. Calvert-Minor also argues that a robust account of objectivity requires humanism in “Epistemological Misgivings of Karen Barad’s ‘Posthumanism.’” [↑](#endnote-ref-13)
14. But say an interlocutor were to approach us with the following objection, “Certainly, matter is a concept. And each individual material—wood, metal, and so on—each is a concept; a trivial point. Surely you wouldn’t try to attribute the results of any experiment, the outcome of the encounter of an electron and a photographic plate, for example, to the *concepts* of the materials involved—or would you try to nourish yourself with the concept of food? To do so would be the worst idealism.” Such an objection misses two essential points: 1) At stake is not merely the production of a result, the trace of the inter- or intra-action of two substances, but of an *experimental* result, the reproducible, conceptual-objective response to a hypothesizing, universalizing call. We cannot arrive at a universal or even momentarily reproducible concept through matter alone, nor can we do so through form or concept alone, but only through an undecidability of form and matter which is the deconstruction of hylomorphism. 2) But can we say, perhaps in retrospect, that it is not the concept of photographic plate, but the matter of that plate that has produced our result? Given that we can ultimately have only empirical concepts (always subject to revisability) of the substances we attribute to nature, it is impossible to say where matter or form begins or ends, and thus on which of the two we base our interpretations (consider how Leibniz employs his favored example of gold in *New Essays on Human Understanding*). No two things or experiences could ever be identified as related in any way unless the concepts or at least the conceptuality governing those similarities somehow pre-existed our experiences of them—though we can never say with certainty what part of our cognition, if any, is a priori. [↑](#endnote-ref-14)
15. On the relation of the Principle of Sufficient Reason to the possibility of experience, see the Second Analogy of Experience from Kant’s *Critique of Pure Reason*, “The principle of sufficient reason is thus the ground of possible experience, that is, of objective knowledge of appearances in respect of their relation in the order of time” (A201/B246). [↑](#endnote-ref-15)
16. “[M]aterial apparatuses produce material phenomena through specific causal intra-actions” (Barad, *Meeting* 153). “Different agential cuts produce different phenomena” (Barad, *Meeting* 175). “Phenomena are sedimented out of the process of the world’s ongoing articulation through which part of the world makes itself intelligible to some other part” (Barad, *Meeting* 207). For another criticism of Barad’s use of the term “world,” see Savransky’s “Modes of Mattering,” ¶ 19. [↑](#endnote-ref-16)
17. Heisenberg reports Einstein as saying, “it is the theory which decides what can be observed” (“Theory” 40, 47). [↑](#endnote-ref-17)
18. A method for relating mathematical representations from quantum mechanical theory to physical properties has been put forward by Pusey et al. (2012). They argue for the ontological status of a quantum state by demonstrating that any ambiguity in its relationship to a physical state contradicts quantum theory (i.e. they prove two different quantum states cannot correspond to the same physical state of a system). Such a conclusion may very well prove provocative for quantum mechanical inquiry (cf. Gao 18–21, 29–41), but it can only obscure the question of the relationship of scientific theory to the real. By this logic, one could easily prove the reality of Newtonian time and space, the luminiferous ether, etc. [↑](#endnote-ref-18)
19. One of Barad’s attempts to do so can be found in *Meeting the Universe Halfway*, pp. 263-64. [↑](#endnote-ref-19)
20. One index of the domestication of this beyond is the description Barad gives of the touching of a particle with a virtual particle in “On Touching—The Inhuman that Therefore I am.” She describes this contact, which occurs entirely within the legislative framework of quantum field theory, as “infinite alterity” and “radically queered” (Barad, “On Touching” 213, 212). Elizabeth A. Wilson, in “Acts Against Nature,” shows how bringing the queer within nature in this way limits its transgressive potential. [↑](#endnote-ref-20)
21. As Barad makes clear, there is anything but consensus on the logical and physical relationship between the complementarity and uncertainty principles among practicing physicists. It is customary to speak of complementarity being “enforced by” uncertainty. [↑](#endnote-ref-21)
22. One sign of this undecidability is the frequency with which neuronal interactions, states of consciousness, and even the “vocal apparatus” of observers are incorporated into quantum states. See, e.g., Peter Lewis’ *Quantum Ontology*, pp. 80-81, 91-2, 130-35. On the impossibility of physical laws distinguishing between measurement and nonmeasurement, see p. 50. [↑](#endnote-ref-22)
23. Qian, Vamivakas, and Eberly, in a 2018 paper, claim to have completed Bohr’s formulation of complementarity, precisely by means of the role entanglement plays in mediating the duality between wave and particle. Whether or not their result stands, it cannot decide between the ontological or epistemological agency of entanglement, in the sense Barad speaks of it. [↑](#endnote-ref-23)
24. Individual scientists may disagree about whether they hold such an objective themselves or believe it possible. For one example of a particle physicist who holds his field to be the best candidate for such a unifying theory see Steven Weinberg’s *Dreams of a Final Theory,* especially ch. 1. That being said, in invoking such doctrinal coherence I am less concerned whether it is the consciously held telos of practitioners than I am to examine whether it is a presupposition of the form of any possible science, whose roots must be traced much further back. To contradict this presupposition of progress toward a unified system of laws, there would have to be a science that could take the conflict of its principles amongst themselves or with observed data as a positive ground of their truth, or at least as no impetus to further investigation. The nomothetic form of all scientific explanation, and the universality and necessity constitutive of the law, prescribe the following forms as the possible results of science: 1) All laws are derivable from highest principles that are in turn in no need of derivation or explanation 2) nature, as it is represented by science, contains ruptures—as we pass from one realm of beings to another laws change abruptly, without explanation or mediation, 3) Science will endlessly work to extend these vertical and horizontal limits, without ever being able to arrive at highest principles that do not allow for further investigation. Even if practitioners understand science in this third sense as an endless task, it remains an open question whether the ideal unity from which such work takes its direction, as opposed to the waystations at which we find ourselves, is the only science worthy of the name. To give one indication of the age and provenance of this question, Aristotle examines the relation of scientific knowledge (ἐπιστήμη) to its first principles in *Posterior Analytics* I.3. [↑](#endnote-ref-24)