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'What could and should the relationship be to our subject matter in science studies – especially when we increasingly work on the same sorts of topic as the people we study?' This is the question that Trevor Pinch (2011: p. 1) places at the center of his review of *Meeting the Universe Halfway* (Barad, 2007). The nature of the relationship between science and science studies is an important issue that I care about a great deal, and the opportunity to engage this question constructively motivates my response. While Pinch and I agree on the question's importance, I depart from his theoretical assessment of the issues, his approach to answering the question, and the answer he proffers. Since my focus is upon this question, I only address misunderstandings of my project that speak to it, and then only some of the more important ones. The pattern and nature of these misunderstandings are significant and telling of important and long-standing differences between feminist and other approaches in science studies.

Pinch delivers his answer to the question of the relationship between science and science studies in the form of an 'uncertainty principle'. As someone who studied quantum physics, Pinch no doubt knows that uncertainty principles represent an absolute *in principle* limit on the possibilities for knowledge-making, not a practical limit that might be overcome. According to Pinch (p. 10), there is a 'paradox of mutual exclusivity between science and science studies': in particular, he says that the practices of doing and writing about science as a scientist *and* doing and writing about science as a science studies practitioner are mutually exclusive. As empirical evidence for his proposed foundational principle, he points to failures of past attempts to practice science studies and science 'as part of the same project' (p. 9) and also to the difficulties of getting scientists and science studies practitioners to engage in productive dialogue.¹

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I am averse to the trick of drawing uncertainty principles out of an analogical hat, and in *Meeting the Universe Halfway*, I point out that even Niels Bohr, who had thought very deeply about such matters, tripped over his own shoelaces in his attempts to do so. My reasons for unhappiness with Pinch's 'uncertainty principle' go much deeper, however. Along with a failure to attend to the crucial philosophical issues of such principles, what is deeply troubling about Pinch's proposed uncertainty principle is that it constitutes a methodological constriction of science studies that altogether excludes both poststructuralist and feminist science studies in principle. To understand why this is so, we need to look at the issues with some care.

The uncertainty principle, authored by Werner Heisenberg, is one of the most important and recognizable features of quantum physics and its divergence from classical Newtonian physics. It speaks of mutual exclusivity, most famously the statement that the position and momentum of a particle cannot be known simultaneously. But the question of how to understand this 'mutual exclusivity' – What is the nature of this constitutive exclusion? – is nontrivial (as we physicists like to say), and it is one of the key issues in *Meeting the Universe Halfway*. I take a great deal of care to offer an explication, since there has been much confusion and disagreement about the issues, and their implications are substantial and substantive. Other physicists, philosophers, and historians of physics have noted the significant epistemological and ontological issues at stake. Feminist and poststructuralist theorists have emphasized that matters of politics, ethics, and social justice are also at stake in understanding the nature of constitutive exclusions.²

The disagreement between Werner Heisenberg and his mentor Niels Bohr, characterized by important differences between Heisenberg's uncertainty principle and Bohr's alternative principle of complementarity, is both a central feature of the historical development of these matters and indicative of a crucial but widely misunderstood substantive set of issues. Pinch misses several key features of complementarity when he invokes Bohr to proffer his own principle of mutual exclusivity for science studies, and that is why I call it his 'uncertainty principle' rather than granting it a place in Bohr's lineage. First of all, complementarity entails *two* important features: mutual exclusivity *and* mutual necessity. For two variables to be complementary they have to be *both* simultaneously necessary and mutually exclusive. Otherwise, what is the paradox? (Many things are mutually exclusive. I can't hang my wash outside and have it dry when there is a downpour, but unless hanging my laundry outside during a downpour is the only possibility for drying it there's no paradox.) Pinch only mentions mutual exclusivity, not mutual necessity. Furthermore, complementarity is not a purely epistemic principle placing limits on what we humans can know (that's how Heisenberg originally wanted to frame it). Rather, the issue for Bohr is one of (ontological) indeterminacy, not uncertainty. Indeed, complementarity is simultaneously an ontological and epistemological matter, but Pinch's 'uncertainty principle' for science studies is purely a statement of epistemic limitations. Pinch also overlooks other key dimensions of complementarity: that mutual exclusivity has its root in understanding measurement as a material–conceptual practice; that material–conceptual practices are simultaneously conditions of possibility and performative actions that produce phenomena inseparable from the apparatuses of production; and that subjects and objects do not preexist but rather emerge from their *intra-action*.³

I understand that Pinch is being a bit loose and ironic in proffering his own ‘uncertainty principle’, and yet at the same time it’s clear that he’s dead serious about the mutual exclusion of the practices of science and science studies. His overlooking of mutual necessity (in favor of a merely epistemic limitation) is thus especially striking. Pinch’s omission is symptomatic of his structural elision of key concerns and methodological imperatives of feminist science studies. From the start, feminist science studies practitioners have insisted on the importance of attending to the mutual constitution of subjects and objects, nature and culture, humans and nonhumans, and science and society, and also, crucially, to how the exclusions that are enacted in making such cuts matter for epistemological, methodological, ontological, and ethical reasons. As such they have avoided singular disciplinary analyses and argued for the need for interdisciplinary and transdisciplinary methodologies. Of particular importance has been the imperative to engage with science, not from a distance, but up close with a focus on the materiality of practices and of matter itself. From a feminist position, to do otherwise is to exclude in principle that which has been coded feminine – namely, nature as agent rather than as passive blank slate awaiting the imprint of culture.

The importance of rigorous engagements with the sciences discussed by science studies practitioners cannot be overstated. Consider this example. In *Meeting the Universe Halfway*, I warn against the tendency (evident in popular writings that invoke quantum physics and in scholarly papers as well) to use physics as a mirror metaphor for thinking about a variety of different issues. It’s not that I’m against metaphoric thinking, but that I am concerned about the temptation when thinking analogically to set up the mirror metaphor and find the same things/relations/patterns everywhere. That is, I warned against an over-reliance on mirroring (whether reflective/reflexive – thereby invoking the very same optics! – or not).⁴ Building on Haraway’s (1997) suggestion of embracing a different optics in science studies – diffraction rather than reflection – I proposed that we think through the physics of diffraction in a detailed and rigorous fashion to see if diffraction might serve as a useful methodological apparatus, not to be used analogically, of course, but rather as an altogether different analytical practice. That is, I proposed what I called a *diffractive methodology* – a practice of reading insights through one another while paying attention to patterns of difference (including the material effects of constitutive exclusions).⁵ Engaging with the physics of diffraction, not by mimicking the physics literature and presenting the physics as a settled issue, but on the contrary, by foregrounding disagreements among physicists as well as relevant new research experiments, and by taking the philosophical issues seriously – that is, by diffractively reading physics, philosophy of physics, and history of physics (to name a few disciplines that were called upon) through one another – I argue that a robust (that is, physically sound, philosophically coherent, and empirically verifiable) understanding of diffraction as a physical phenomenon and a rigorous analytical tool comes to the fore. In particular, Heisenberg’s reading of mutual exclusivity as an epistemic limitation does not hold up to scrutiny, on philosophical and empirical grounds. By contrast, my agential realist reconstruction and further elaboration of Bohr’s interpretation coheres not only philosophically but also with the latest physics experiments. What I call Bohr’s philosophy-physics – his refusal to hold philosophical and physical issues as separate considerations – is crucial to these developments. Pinch’s portrayal of physicists as

uninterested in philosophy is outdated (on historical and methodological grounds).⁶ There is now a multitude of evidence against Heisenberg's uncertainty interpretation and in support of Bohr's – see especially the recent quantum eraser experiments! And Pinch's advocacy of a separation between science and science studies in the form of an uncertainty principle (derived in precisely the problematic mirror fashion I cautioned against), would undermine significant historical as well contemporary efforts to understand and be responsive to the world we live in and of which we are a part.⁷

In contrast to Pinch, I'm not interested in putting forward some principle about what constitutes the proper practice of science studies. I believe that would be deadening. I do think that engaging in practices we call 'science studies' together with practices we call 'science' can produce and have produced important and significant results that are not otherwise achievable. Indeed, I argue in *Meeting the Universe Halfway* that such conjoined considerations (as practiced by individual scholars or in collaborative groups) make possible an understanding of the entangled co-emergence of 'social' and 'natural' (and other important co-constituted) factors that are needed in efforts that strive for the responsible practice of science. As a scientist and a science studies practitioner, I am committed to creative endeavors that seek to open up spaces and opportunities for these conjoined efforts. Not only is the world too complicated for any one set of disciplinary considerations to do justice to the complexity of the issues – although I believe that is surely the case – more importantly, a continued insulation of different (inter)disciplinary practices from one another risks missing some crucially entangled epistemological, ontological, and ethical issues. I think that understanding these entanglements is essential for science studies, and so Pinch's effort to rule them out in principle is debilitating for the field.

This is not to say that these conjoined efforts come easily. Nor can we assume that they are methodologically straightforward, but this doesn't mean the methodological difficulties are (inherently) intractable. Each discipline has its own vocabularies, methods, standards, ways of making and responding to arguments, evidence, and so on. That is why I proposed a diffractive methodology: before undertaking the project of thinking science, science studies, and feminist and queer studies (significantly, Pinch leaves these latter fields completely out of the picture) together, I had to find a methodology appropriate to the task, one which would be respectful of different disciplinary approaches and the differences between them, and sufficiently rigorous to provide new insights recognizable by scholars in the various disciplines with which I engage. I tested the methodology by challenging myself to make good on the claim that I could derive new results in this way.

Among my more rigorous experiments was the effort to work out the implications of agential realism for an ongoing research question in physics. In *Meeting the Universe Halfway* I propose an agential realist interpretation of quantum physics (including a solution to the famous measurement problem). This agential realist interpretation is vulnerable to empirical results, as it should be. It has to cohere with what we know.⁸ And likewise, yes, scandalous as it may be to some, agential realism could ultimately prove to be wrong, or at least not sufficiently responsive to various 'human' and 'nonhuman' intra-active engagements that matter. That vulnerability, to my mind, is a real strength of any theory ('scientific' or otherwise), not a failing. Theories are not sets of free-floating

ideas but rather specific material practices in the ongoing intra-active engagement of the world with itself, and as such they are empirically open and responsive. That is, they are always already part of what the world does in its ongoing openness and responsiveness to itself. Why would we want it to be otherwise? Why would we want theories to be shielded from the world?

Which brings us to what Pinch (p. 2) describes as an ‘ouch’ moment. My memory of our interchange at Stevens Institute of Technology differs from Pinch’s account.⁹ Since Pinch’s review essay echoes some of the same communicative misfirings that frustrated me at the time, I will discuss some of the more important elements of our interchange as I remember them.

As I understood it, I was invited to the conference at Stevens to address the conference theme of imagining constructive engagements between the sciences and the humanities. In response, the main focus of my talk was bringing to light the importance of troubling the nature/culture dichotomy, which is the foundation for a presumed gap between the proper objects of concern for humanities scholars, on the one hand, and scientists on the other, and proposing an alternative approach that explores possibilities for intra-active engagement of different disciplinary concerns, facilitated by a diffractive methodology. At the end of my talk, I illustrated the possibility of constructive engagement between the sciences and the humanities by a rather unconventional interpretation of the ‘quantum eraser experiment’ (Barad, 2009).¹⁰

After my talk, Pinch raised an interesting question: What if the quantum eraser experiment had showed that Bohr was wrong, would that matter for agential realism? I took it to be a friendly question and an opportunity to highlight some of my key points. I said I wanted a philosophy that was responsive and responsible to our intra-actions with the world. And that a strength of my approach is that it offers a way to take empirical data seriously, without embracing either a naive empiricism that elides important social factors or a social constructivist approach that excludes natural factors or agencies. These more familiar approaches take the nature/culture dichotomy for granted, whereas agential realism understands the objective referent for empirical claims to be material-discursive phenomena (with the notions of objectivity and referent appropriately redefined). I noted that we could all agree that one experiment never makes or breaks any theory, and with this proviso, agential realism offers a possibility for thinking ‘the social’ and ‘the natural’ together in a way that is responsive and responsible to the world.

I was astonished by Pinch’s interjection that my response undermined everything I had said in my talk. As he continued with this ‘gotcha’, it was immediately obvious that his response relied on serious misunderstandings. To understand their source I need to say a bit more about my talk.

I did report on the results of the recent quantum eraser experiments, no doubt with all the enthusiasm of a scientist (for which I am unapologetic). I can see how an enthusiastic presentation of new experimental results might suggest a straight realist account by an uninformed scientist indifferent to science studies and its crucial insights. But anyone attentive to my presentation would have been hard pressed to make such a rash assessment. There was something highly irregular, one might dare say queer, about my presentation that just doesn’t fit the straight realist performance. After explaining agential realism and my diffractive methodology I paused and displayed this slide quoting Jacques Derrida and posing a provocative question and promise:

The concern is ‘not with horizons of modified – past or future – presents, but with a “past” that has never been present, and which never will be, whose future to come will never be a production or a reproduction in the form of a presence’ [Derrida (1982: 21)]. Can physics help us make sense of this? Not Physics as an un(re)constructed Truth, but physics read through the insights of Derrida can! (Barad, 2009)

Only then did I proceed to talk about the quantum eraser experiment. Can quantum physics (a theory renowned for its difficulty) help us make sense of a literary theorist and philosopher famous for the seeming impenetrability of his writing, and vice versa? What straight realist presentation prefaces an account of an experiment with the statement: ‘Not Physics as an un(re)constructed Truth’? Invoking Derrida – the ‘poster boy’ for social constructivism gone wild (a misguided attribution if ever there was one, but so it is), the one theorist nearly everyone but deconstructionists and poststructuralists loves to use as a foil for their own supposed reasonableness, the science warriors’ darling stand-in for all that is wrong with the humanities – undercuts any pretense of a convincing straight performance. I suggest that Derrida could help us think through the issues of temporality posed by the quantum eraser experiment ... IF (admittedly a big ‘if’) Derrida is read in a materialist agential realist (not social constructivist) mode (thereby rescuing him from some of his biggest fans)!¹¹ For a diffractive reading of insights of Derrida and agential realism through one another to have constituted a straight realist presentation by a narrowly disciplined scientist, some serious erasing would have to go on after the fact!

How it is possible that Pinch could overlook the queerness of what I said to fashion me as a straight realist? (Or at best, a straight realist dressed in standard-fare scientist garb with unmatched social constructivist accessories awkwardly adorning my outfit?)

One needn’t look very far for clues. Precisely where Pinch thinks my account starts to lose its clarity is just at the point where I seriously engage with feminist and queer poststructuralist theories. Admittedly, these theories are difficult. Pinch is not the first one to complain that clarity and poststructuralism are mutually exclusive, thereby begging the question of clarity for whom, by whose standards? When calling into question the terms of widespread and widely accepted theoretical ideas, care must be taken that one’s language doesn’t rely on the same set of assumptions being questioned. Creative and non-straightforward forms of expression are then not optional. Bohr understood this point, and his self-conscious use of language contributes to complaints about the density and lack of clarity of his writings as well. Difficulties aside, the structured lack of appreciation of poststructuralist contributions and how these theories matter to feminist, queer, postcolonial, and critical race theories, is significant. Pinch’s erasures are not his alone.

The erasure of feminist contributions to science studies has a long history. Pinch (p. 10) provides a telling symptom in this statement:

Barad states that feminist science studies is about gender and science in the making, or co-constituting one another, and although she does emphasize a new ethical framework that stems from her post-humanist viewpoint, and claims that understanding how bodies are made materially has important consequences for gender, I failed to see how this understanding impacted the version of the entanglement experiments as she presents them.

Pinch's failure to understand is already evident in his looking for a gender analysis of the quantum entanglement experiments. My book's only reference to gender-and-science-in-the-making is in a very brief review of 'reflexivity'.¹² My concern as a feminist scholar is not women or gender per se, but rather an engagement with feminist understandings of the political. A monocular focus on Politics with a capital P (and only a very particular slice at that) obscures crucial dimensions of politics and power. That is one reason post-structuralism has been immensely important for feminist, queer, critical race, and post-colonial theorists.

Pinch seems aghast at my suggestion that insights from agential realism might have interesting implications for science studies. But, ironically, his breathless run through agential realism (in one short section, mostly in one short paragraph [pp. 7–8]) not only misses the political dimensions of my analysis, but erases my reliance on insights from science studies in developing agential realism. The diffractive methodology I propose involves a special kind of 'reading through' as it were: diffraction is an intra-active phenomenon, and as such does not hold one set of concerns as pre-existing or stable or primary over another.¹³ By design, no one discipline is held over any other, dictating how practitioners in some other field should legitimately practice their craft. But I found it especially surprising that Pinch completely neglected how the importance of science studies insights for agential realism matters for science studies. Why wouldn't this be a point to highlight? After all, in subsequently offering an agential realist interpretation of quantum physics that does cohere with the latest scientific findings, I demonstrate the relevance of science studies for the *practice* of science. I thought that was one of things 'we' wanted to be able to show. Could Pinch have missed what agential realism, and feminist and queer studies for that matter, have to do with science studies because they aren't a variety of social constructivism?

The limitations and shortcomings of social constructivism have been widely discussed by both science studies and feminist studies scholars. Social constructivism both assumes too much and leaves out too much. In its heyday, social constructivism offered important insights and an important counterweight to scientific realism and other ways of taking the natural for granted. But as Callon and Latour (1992) correctly pointed out during the epistemological chicken debates, social constructivism – the view that natural facts are not simply given but rather constructed through the mediation of social reality – is really social realism, a form of representationalism that takes the social for granted. Rouse (1996) and Hacking (1983) were particularly eloquent about the fact that social constructivism and scientific realism share the same assumptions, including that knowledge is about representing rather than practices of intervening. Feminist science studies scholars and feminist poststructuralist theorists emphasized that social constructivism's founding gesture was always already gendered. Its foundational hypostatization of the nature/culture dualism, including the gendered assignment of the social in the active (gendered male) role of agent inscribing the passive (gendered female) slate of nature, obscures crucial dimensions of power. To begin analysis with the nature/culture dichotomy already in place is to begin too late. Understanding the construction of the nature/culture dichotomy and the work it does has been crucial; it is not enough simply to acknowledge *that* it matters, but we must understand *how* it matters and *for whom*. For all the important insights social constructivism brings to the fore, it runs aground in its

reliance on the nature/culture dichotomy and human exceptionalism, and its failure to take account of the material practices that produce and enable the particular social and historical framings that provide social constructivism's point of departure. In ascribing matter/nature to an outcome of social practices, social constructivism never gets around to asking how matter matters. It permits only a one-way analysis, at best.

Agential realism takes social constructivist insights and those of performative alternatives in science studies and political theory, and reads them through other insights, including Bohr's philosophy-physics. Bohr's insights are key because his own proto-performative materialism asks after the conditions of possibility of the crucial social practices of meaning making. With some further elaborations, agential realism understands apparatuses as material-discursive practices that are simultaneously the conditions of possibility of meaning making and causally productive forces in the intra-active materialization of phenomena – that is, apparatuses are about mattering in both senses of the term. What is at issue here is not trading a one-way monocular analysis for a two-way monocular analysis to repair the limits of social constructivism, but rather a problematizing of methodological approaches that would take either the social or the natural as primary and preformed categories. Agential realism is attuned to the intra-active constitution (rather than two-way production) of subjects and objects, nature and culture, and matter and meaning.

In closing, I want to rewrite the scene of Pinch's erasures by underlining the importance of feminist science studies' contributions. For all its internal differences, feminist science studies does not hold as its first priority the proper description of what it is that scientists do, but instead asks: How might science be practiced more responsibly, more justly? This issue is my passion, which is what drew me as a scientist into the discussion in the first place. It is no coincidence that so many feminist science studies scholars have been trained as scientists and that we have not shied away from expressing our deep love for science and this astonishingly remarkable, intricate, amazing world of which we are a part. Photons and electrons leave me in awe. So too brittlestars, humans, ferns, and so much more, always more. These critters do more to deconstruct science (and others of our assumptions) than anything going under the name of social constructivism. Put another way, if we look carefully we can see science in its power-charged conversations with (or rather, as part of) the world deconstructing itself at every turn. The turn to ontology does not turn away from epistemology, when knowing is recognized as an activity the world engages in. And ethics, that is, matters of justice, are never secondary or derivative concerns.¹⁴

An already significant body of work is committed to the conjoined practices of doing science and science studies, a set of practices that I would identify with feminist science studies. *Meeting the Universe Halfway* is a part of that longstanding tradition in feminist science studies that focuses on the possibilities of making a better world, a livable world, a world based on values of co-flourishing and mutuality, not fighting and diminishing one another, not closing one another down, but helping to open up our ideas and ourselves to each other and to new possibilities, which with any luck will have the potential to help us see our way through to a world that is more livable, not for some, but for the entangled wellbeing of all. I am delighted and privileged to be a part of a very diverse set of conversations, approaches, and practices that are committed to conjoined considerations of

different (academic and nonacademic) material practices, including thinking about and practicing science together as one integrated activity. Activists and practitioners at every stage of academic achievement, from undergraduates to seasoned senior professors, already engage in this important and generative work.¹⁵ Feminist science studies was never a subfield of science studies that talked about women and gender. Feminist science studies, for all its diversity and because of all its diversity, is a richly inventive endeavor that is committed to making a better world. Attentiveness and responsiveness to material differences and material cuts and how they matter makes conjoined engagements within the world not a mere academic curiosity or luxury. Engaging science in a serious manner shows us why and how matters of science (including esoteric features of quantum physics, such as the uncertainty principle) are always already intra-actively entangled with questions of politics and power. Who and what gets excluded matters.

Theories are not mere metaphysical pronouncements on the world from some presumed position of exteriority. Theories are living and breathing reconfigurations of the world.

Agential realism, like all philosophies, won't live or die by one testable result alone, but it must be alive and open to the world, or it's a life that will be very short-lived. It is very gratifying to see young feminist scholars already offering their own elaborations.¹⁶ Our meta/physics, like all good scientific theories, should be alive, responsible, and responsive to the world. How else will our theories matter?

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Notes

1. Of course, this kind of evidence would only lend support for a much weaker principle, but in any case Pinch's offering of empirical evidence *sans* 'social context' (which goes to his standard for making reference to 'the data') is more than a bit ironic. If science studies practitioners criticize scientists for making claims on 'the natural', what standards apply for making claims on 'the social'? Furthermore, there are significant data that speak against Pinch's claim, showing that science studies practitioners and scientists can and do work together productively.
2. For example, works by Judith Butler, Jacques Derrida, and Donna Haraway emphasize these issues. In *Meeting the Universe Halfway* I elaborate on the entangled relations between these diverse practices (including scientific and social theories) that share a concern with questions of exclusion.
3. *Intra-action* is my term, not Bohr's. I introduce this neologism to help clarify and to mark a crucially important insight in Bohr's philosophy-physics. *Intra-action* is a key concept in agential realism. Pinch writes that 'intra-actions' are 'interactions between two entities, not only a human and a non-human' (p. 8). But I introduced *intra-action* to signify 'the mutual constitution of entangled agencies. That is, in contrast to the usual "interaction", which assumes that there are separate individual agencies that precede their interaction, the notion of intra-action recognizes that distinct agencies do not precede, but rather emerge through, their intra-action' (Barad, 2007: 33).

4. For example, I described at some length problems with playwright Michael Frayn's (2000) proposed 'uncertainty principle', noting the difficulties that arise because 'Frayn presents his audience with a set of binaries – the social and the natural ... – and his approach to relating the two sets is to draw analogies across the gap' (Barad, 2007: 5). Haraway (1997) is eloquent on this point of mirroring's reproduction of the same.
5. To elaborate a bit more, a diffractive methodology is a practice of simultaneously attending to important differences among practices and their specific entanglements by reading respective insights through one another in a way that does not build in foundational distinctions and separations before the analysis gets off the ground, and that is responsive to our intra-active engagements with our subject matter, including attending to what gets excluded and how it matters. For details, see especially Chapter 2 of *Meeting the Universe Halfway*.
6. While most physicists were happy with backgrounding philosophical issues for a period of time, there have always been physicists who have demonstrated a long-standing interest in philosophical and historical issues, and all the more so now that the latest physics results (what I have called 'experimental meta/physics') are once again foregrounding them. See, for example, David Mermin, Sam Schweber, Michael Nauenberg, Arthur Zajonc, Herb Bernstein, Lee Smolin, and Anton Zellinger, to name a few.
7. Whether 'we' like it or not, science and interdisciplinary science studies are already ontologically and epistemologically entangled practices, with stakes in defining what gets to count as nature (and its constitutive others). To take but one example, should we say to Bohr that he had no right to think about the issues of philosophy and of physics together? Who gets to decide which considerations count as 'physics' and which count as 'philosophy'? Shall we deny the fact that 'physics' – nay, 'natural philosophy' – and what we now call 'philosophy' (proper) were cooked in the same cauldron at a time when knowledge practices did not involve professionalizing disciplines in ways we are accustomed? How do these separations (continue to) get worked out? Should we try to take these entanglements into account somehow or leave them behind as interesting but irrelevant historical artifacts? Is the contingent emergence of these 19th century disciplinary divides the one place where Pinch thinks the history of science has stumbled onto a deep truth about nature? Or to speak on a personal level, what would it mean to hold back the 'physicist side' of me when I do 'science studies' and vice versa? How would one go about making these cuts and on what basis? How would the cuts matter? And what would get left out? What are the constitutive exclusions?
8. Of course, 'cohere' is not a transparent standard, but instead emerges from within an evolving set of practices, including social issues and practices that are an integral part of physics.
9. The meeting was 'Science, Technology, and the Humanities: A New Synthesis', held at Stevens Institute of Technology, Hoboken, NJ, USA, 24–25 April 2009.
10. The quantum eraser experiments have profound implications especially for thinking about the nature of nature and of time (for a detailed account and relevant references see Chapter 7 of *Meeting the Universe Halfway*). The quantum eraser experiment (in delayed choice mode) reveals the perverse possibility of changing the nature of nature *after the fact* – that is, the identity of the object in question – be it wave or particle – can be changed by erasing the 'which-slit' information *after* the object has already gone through both slits as a wave or one slit or the other as a particle! These experiments were not proposed or tested until the 1990s (for example, Scully et al., 1991). Pinch chastises me for not being interested in history and not referencing Harvey (1981) when I talk about the quantum eraser experiments – but unless Pinch was performing a quantum eraser experiment on Harvey's paper – which rewrote later results into a paper from an earlier time period – or, Harvey was doing some time-traveling of his own, Harvey couldn't have analyzed the quantum eraser experiments that I was talking about since these experiments were not even conceived until a decade later.

11. Derrida rejected the description of deconstruction as poststructuralist, but this not the place to split those hairs. In any case, contrary to popular usage and belief, deconstruction is not about taking everything apart and not putting anything together again; rather, deconstruction is about bringing constitutive exclusions to the fore, because the texts/materials that are deconstructed are precisely what we can't live without. It is attuned to *the constitutive exclusions of mutual necessity*. Thus lives the spirit of Bohr.
12. In particular, in preparation for talking about Haraway's creative suggestion to switch optical metaphors from reflection to diffraction, wherein she also raises the issue of the politics of difference in feminist science studies. See Barad (2007: 87) and Haraway (1997: 33–36).
13. That is, intra-action is not a simple bidirectional (rather than unidirectional) form of causality, but rather entails a rethinking of the very terms of causal relations (Barad, 2007).
14. According to agential realism, ethics is not to be understood as a matter of assigning or parsing out principles of morality, as contrasted with questions of social justice. On the contrary, ethics is about mattering, including who matters and who doesn't, as well as how even the very conception of matter entails particular constitutive exclusions.
15. It is important to acknowledge the extended overlapping webs of shared practices that constitute Feminist Science Studies. While it is both tempting and expected to use standard citation practices in the form of lists of representative contributions that are said to constitute a field, such practices are also deeply troubling. They are troubling not only for the constitutive exclusions they necessarily enact (Who's in? Who's out?), but also for the affective effects they spawn, no matter how unintended, and because of the performative delineation of the boundaries of the field via the mechanism of saying whose work is properly representative and whose isn't. Hence, I resist the standard practice here while acknowledging a very extended web of practices so designated that reaches across genders, races, sexualities, and nationalities.

Perhaps it is because there has been and continues to be a strong tradition of scientists doing feminist science studies that some of us have persisted in creating opportunities to engage constructively with scientists with the goal of thinking about and practicing science together as one integrated activity. I have had the great privilege of being involved in different intellectual practices where natural scientists, engineers, social scientists, scholars from the arts, humanities scholars, journalists, political activists and others can come together and practice the co-consideration of the insights of our disciplines, interdisciplines, and nondisciplines. Currently, I have the pleasure of being an active participant and one of the founding members of the UCSC Science & Justice Working Group (directed by Jenny Reardon) and co-director (together with Jenny Reardon) of UCSC Science & Justice Graduate Training Program (for more information see <http://scijust.ucsc.edu>).

16. One such example in this journal is a recent paper by Astrid Schrader (2010).

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Biographical note

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