Karen Barad's Feminist Materialism

Karen Barad's Feminist Materialism:

Intra-action and Diffraction

By

David Harris

Cambridge Scholars Publishing

Karen Barad's Feminist Materialism: Intra-action and Diffraction

By David Harris

This book first published 2021

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN (10): 1-5275-6292-1
ISBN (13): 978-1-5275-6292-9

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I would like to thank family and friends who have supported me in this work.

INTRODUCTION

The work of Karen Barad is extensive. I read the main book (Barad 2007) several times. I managed to acquire most of the journal articles (Barad n.d., 2017, 2016, 2015, 2014a, 2014b, 2012, 2011, 2010, 2003, 1998), interviews (in Jeuleskjaer, and Schwennesen, 2012 and in Kleinman, 2012), and some of the book chapters in English (Barad 2014c, 2008a, 2008b, 2001, 2000). I have no German, so that work is inaccessible to me. There is some overlapping in the different publications. It is still a massive body of work, and I can only select themes which I think are both personally interesting, and central to Barad's work: the chapter titles indicate my interests. Barad's work has been influential in several fields, in feminist theory, and in feminist studies of science and technology. We shall see how those explorations of "entanglements of matter and meaning", to use the phrase in the subtitle on the cover of Barad (2007), also come to focus on the notion of diffraction as a method, with wider application.

The first two themes connect because Barad proposes a substantial revision of "reality", the "natural world" and its relationship with human social and cultural developments. A particular concept of passive nature has been central to some patriarchal argument, of course, and it involves seeing women as closer to nature, somehow both naturally distinct from men and as inferior to them. It is that particular concept that Barad wants to undermine. That concept was accompanied by a notion of science as the dispassionate, rational observation of external reality by male scientists who had apparently escaped any cultural contaminants from their social locations and genders.

There are broader implications, and Barad also wants to reject the conventional assumptions that see animals or geographical territory as mere objects or resources. A wealth of examples in her own and others' work shows that it is not easy to justify human exceptionalism in these areas, since Nature evidently displays a certain "excess" or "exuberance" and is not just a passive material substratum. This more active conception is usually indicated by the capital letter. More specifically, there is a general support for Nature's "queerness", the absence of rigid binary

distinctions, and this is used to argue for a general support for queer sexuality in human affairs.

All these implications are developed after a substantial summary of debates in quantum theory. Barad sees both connections to and implications for a wide range of material, from biological studies of starfish and other puzzling creatures, through sociological studies of workers and social relations in a jute mill in Calcutta, to a well-known commentary on colonialism in Central America, and to memoirs of a Hiroshima survivor. There is also a major theme expressing the challenge to conventional notions of time in the work of Jacques Derrida, mediated through positions developed by other feminist materialists such as Vicki Kirby (for example Kirby 2011) or Astrid Schrader (for example Schrader 2012). Kirby, Schrader, and Ewa Ziarek (2001a) all have a significant role in extending Barad's arguments as well as making their own, and the former is my focus.

The detail of how Barad's work is connected internally reveals the central problem for diffraction as a method. It will be a problem to relate different arguments together, and any two-level arguments linking general philosophy and concrete analyses risk particular incoherence. Barad proposes that her pursuit of diffraction can resolve this incoherence to her own satisfaction, through concepts such as "entanglement", but it is less clear that she employs this as a systematic method, one that can be used by others and does not just depend on her own undoubted virtuosity.

In any attempt to critically evaluate this work, there are obvious difficulties. One is its enormous scope: the arguments range across several disciplines and it is difficult to find a way to engage with areas that are unfamiliar to me, like quantum theory. Anyone in academic life also knows about the awful vertigo which is generated on reading a substantial text, even in familiar territory, if it refers to other substantial texts, which refer to others almost *ad infinitum*. I have set the rather arbitrary limit of pursuing Barad's arguments only to the first stage, by reading the texts she cites most frequently, or ones which seem most important to her argument. The large list of work which "applies" Barad on diffraction has been managed by relying upon my own interests, which include qualitative educational research, and by estimating which pieces have been most influential, or at least most cited elsewhere.

The individual K. Barad is not easily detached from a whole group of feminist materialists operating with similar ideas. Several writers

shared ideas with Haraway, for example, including her concept of "diffraction" (Haraway 1997). Collections of work in which Barad appears, such as Smelik and Lykke (2008), seem to have been produced by a network of participants from different nations and disciplines contributing to shared research. Nevertheless, the role of quantum theory in the subsequent arguments is systematically expounded only by Barad. Barad uses the term "diffraction" with a particular emphasis from quantum theory to describe her attempts to discuss her chosen material in a particularly authoritative way. Formidable difficulties obviously confront any non-specialist commentator.

There are many examples trying to apply a diffractive approach to a variety of topics. The main claims made for diffraction as a new method turn on its critique of the old "reflection" model of knowledge production that saw human knowledge as somehow reflecting, or reflecting back onto, objective, material data. Obviously, binary distinctions of the kind we have already seen are involved in that model.

There is another strand connecting to feminist support for more affirmative argument generally in academic fields—the old forms of academic critique, which exposed allegedly terminal flaws in earlier positions, were unhelpful. This might be seen in feminist work itself where earlier generations of feminists have sometimes been simply dismissed by later ones as Geerts and van der Tuin (2016) explain. It was common to pursue critique like this from an allegedly anonymous perspective in a "god's-eye" view. For these reasons, Barad and her supporters have found it much more profitable to read several pieces of work together affirmatively, as working "through" and "with" each other in what is claimed as a new approach.

Nevertheless, some critical evaluation seems to be important, even if we are to just apply Barad's insights. Using her method of diffraction, for example, surely requires that we understand it thoroughly first, or else we might be offering a more inadequate version. Her version obviously emerges from the more general discussions of quantum theory. Trying to examine what she might have meant can involve forms of internal or "immanent" critical analysis, where we explore the arguments already in the work, trying to weigh evidence, examine consistency, look for suppressed alternatives and unresolved issues. This immanent critique has been practised in other critical traditions, including Critical Theory (see Adorno 1973). Critique like this need not be negative and dismissive and might even encourage further thinking.

The obvious source to draw upon to support this sort of analytic critique in Barad's work, however, is Derrida. The results of his famous "deconstructions" have a prominent place in her work, especially his critiques of the notions of space and time in Western metaphysics. It seems odd to then deny the applicability of Derrida's method, which involves close and detailed interrogation of the central arguments in a range of work. There is a focus on how they are constructed, how "writing" in the most general sense produces actual argument from a virtual infinity of possibilities. These connections are not purely logical ones, of course. One particularly famous argument from Derrida concerns "logocentrism", the tendency to short-circuit logical or theoretical argument with occasional interventions based on some immediate perception, which somehow appears directly in consciousness (for example, Derrida 1991a). Derrida himself says that all argument is deeply mired in logocentrism, including his own, and it might be profitable to see how it might be managed in the works of feminist materialism too.

Derrida is not claiming to be operating from some privileged point beyond all social contaminants and positions. He is offering an analysis based on a much more familiar form of authority. He writes as an accomplished scholar with clear evidence of his expertise in translation, in linguistics and in philosophy. This position could still be seen as elitist and having connections to patriarchal power, as his own term "phallogocentrism" implies, but there are no easy ways to be able to avoid these associations, and he draws attention to their limitations on several occasions. The conventionally anonymous and impersonal style of many academics can also be attributed to the constraining power of existing scholarly conventions rather than to a commitment to some remote god-like non-positioned perspective, as Sehgal (2014) argues in her diffractive reading of Whitehead. Those conventions, and the claims to authority they support, are found in feminist materialist writing too, with additional ones combining open political and ethical commitments, sometimes based on personal experience.

I focused on the topic of educational research when discussing diffraction, because I am interested in seeing how a diffractionist approach might help to overcome some obvious and specific difficulties of some earlier traditions, especially in qualitative research. For example, there is a tradition dominated by a version of "social constructionism" which ends, inevitably in my view, in unhelpful relativism requiring some rather arbitrary supplementary ethical or political commitments (see for example Denzin 2006). In the same spirit, qualitative researchers have long rejected

scientism until recently, the claim that the methods of the natural sciences are the most reliable and objective and should be emulated, especially in educational research. Barad has done much to reject relativism and restore science as an important area for feminists, even designing successful undergraduate courses to do so (Barad 2000).

In the USA and the UK, educational research methodology has become an explicit political issue, with funding being directed toward "scientific" quantitative research, and qualitative research left to wither. The relatively sudden interest displayed by educational researchers in physics, albeit quantum physics, might indicate a congruence of material interests as well as scholarly ones. Pinch (2011) suggests there have been such social and political material implications before, where quantum theorists saw increased funding opportunities if they could stress the connections between their work and philosophy, or even with New Age culture, before finding major military and corporate interest and substantial funding during the Cold War.

In the interests of further denying any god-like stance for my work, I should openly confess to being an elderly male academic. Despite my best efforts to identify any distortions that might result, I am sure some effects of my identities are detectable. Even Derrida admits that he might not be able to fully understand the perspective being pursued by one of his female interlocutors. I am also a sociologist, and this might provide a problem in that sociologists are probably those most committed to an approach that stresses language and culture to the exclusion of the biological and natural, despite various "turns to the body". Encountering these materialist arguments has proved particularly challenging, but also stimulating.

There are some other constraints in the form of academic work that I read earlier. I read Barad after an immersion in the work of Deleuze and Guattari. I began with her 2007 book and then followed up. This might well have had effects. I was sympathetic to Deleuze and Guattari on the existence of virtual reality, and this probably meant I found Barad more elusive in her discussions of the virtual level of reality. I read Barad before I read Kirby, with a similar effect on my estimate of Barad's grasp of Derrida. These effects of sequence are inevitable and need more discussion when considering diffraction as a method.

However, I also want to draw on my original discipline and criticise aspects of the argument that assume that philosophy is somehow

free-floating, devoid of any social interests. Immanent critique forbids too much exposition, but the example to follow here is Bourdieu's brief critique of Derrida (Bourdieu 1986) during his general contestation of the autonomy of philosophical value judgements. After reading Bourdieu, I have seen Derrida as well as Barad stopping short at the most interesting moments, when trying to explain the social context for, and the interests in, particular judgements in philosophy, and thus operating with apparently independent developments in thought alone.

The most obvious case for me arose when Derrida (1991b) rebukes Hegel for simply reproducing a conventional view of the Prussian bourgeois family in his analysis of the emergence of the "community" dimensions in political philosophy. This is an example of the cognitive flaw of logocentrism, but there are powerful social supports for seeing such a family as normal as well. Parsons's (1959) work on the nuclear family argued it is a universally functional form, for example, but various Marxists and feminists suggested that nuclear forms are functional specifically for patriarchal capitalism. I also thought of Colletti's Marxist critiques of Hegel (Colletti 1975), saying that Hegel reproduces an "ideological" account of the state which actually supports the Prussian monarchy despite appearing as some embodiment of pure Reason. Materialised social forces and the ideologies associated with them are at work to prefer and sediment, if not actually initiate, versions of logocentrism.

More generally, there is an issue to which Bourdieu again refers, best of all in Bourdieu (1988). Theorists are not free-floating intellectuals, but university employees. The struggle for prestige between rival disciplinary schools and faculties is seen as important in French higher education, and it is likely that effects can be found in all academic work. This is not to denigrate scholarship or reduce it to a cynical matter of competing for resources, but rather to acknowledge that there are constraining contexts provided by work environments themselves. Even Derrida refers, rather briefly and uncritically, to the ways in which the "code of the University community" (Derrida 1991f, 417) affected the work of Levinas, lending it a sense of presence. Some of the conventions being criticised in Western scholarship—neutrality, objectivity, competitive forms of engagement with the work of others—are over-determined by the organisational settings for academic work in universities and research laboratories. Agendas establishing theoretical and philosophical issues that seem taken for granted do not occur only in those logocentric moments of subjective certainty and discovery but are also

provided by institutionalised research programmes. Practitioners can adopt them as second nature. These are perfectly understandable constraints on academic work, but they are rarely acknowledged.

Another aspect of sequencing academic work in practice is that diffraction is not easily separated from critique in academic traditions. Newtonian physics is thoroughly critiqued in Barad, as are Cartesian conceptions of the individual or of the separation of subject and object. Rival approaches in quantum theory are dismissed. Some contemporary alternatives are critiqued, especially Judith Butler's. The critique is political as well as theoretical. All diffractive approaches seem to follow on from critique of earlier positions, partly, no doubt, because work must be justified continually as "new". To use some of the Baradian terminology to be developed later, every systematic approach, including diffraction, involves a "cut" in thinking and argument, so that affirmation excludes as well as includes.

One aspect of conventional critique that seems to be at risk is the idea of corrigibility. A formulation associated with Karl Popper (2002) insisted that a distinctive characteristic of science, demarcating it as a specific discipline, was falsifiability, the possibility that conjectures, hypotheses and whole arguments might be shown to be wrong, ideally by some crucial empirical experiment. Subsequent discussion, as Pinch (2011) pointed out indicated that the whole process depended on there being a critical public community of scientists willing to develop such experiments, and to be bound by the results. Barad gives an excellent example of such a productive engagement in discussing the controversies between Böhr and Heisenberg. The quantum experiment which resulted generated enough accepted empirical data to decisively support Böhr. A version of reasoning supported by experimentation remains in Barad's (2007) discussion of objectivity as involving the reproducibility of results. This is less commonly held outside natural science, yet even there, arguments can be written in a way which risks the possibility of being shown to be wrong. Indeed Barad (2011) herself says she is prepared to be shown to be wrong. Perhaps oddly, though, Barad even suggests, repeatedly, and much more controversially, that empirical results can somehow support Derrida's notion of "hauntology", as we shall see in Chapter 1.

That tendency to develop experiments or investigations that might correct theories and hypotheses still seems to be valuable, but it is not so prominent in some of Barad's extensions of Böhr nor in diffraction

approaches. Instead, cognitive endeavour is also judged on ethical and political grounds, and corrigibility ceases to be distinctive. We can see this in several stages of the argument in Barad that ethical, epistemological and ontological analyses are inextricably interwoven, so much so that she proposes a single if hyphenated word to describe the endeavour—"ethico-onto-episto" (Barad 2007,185). In an abstract sense, of course, that might be an accurate description of connected implications, but in practice the relative elements often need to be separated or prioritised. It is possible to conceive of situations where ethical considerations might simply outweigh any epistemological or ontological considerations, in human experiment above all: I suggest a clearly unethical one myself in Chapter 1, just to draw attention to the issues. At the end of her 2007 book, and again in her interview in Dolphijn and van der Tuin (2012), Barad gets close to suggesting that ethical considerations, an absolute respect for others, apparently based on Levinas, should be the dominant consideration. In an earlier example, however, Barad (2007, 370f) discusses a particular experiment on brittle starfish, pursued by Aizenberg et al. (2001). None of the authors makes any comment about the ethics of the experiment, even when the starfish is taken into a laboratory where it "donates" one of its limbs. Nor is the epistemology particularly controversial, although it seems to involve standard positivistic and reflectionist statistical modelling techniques. All this is forgiven, as it were, by the ontological implications of the experiment, that brittle starfish are not as clearly separated from human beings as is conventionally assumed. This move from abstract principles to consider how specific analysis proceeds is a main theme in this book.

There is no easy way to condemn approaches as being simply "wrong" of course, and no intention to do so. Instead, at its simplest, there is an interest in how the differences between the various components in Barad's work are managed, made coherent or rendered irrelevant. Barad's work is very extensive, as we saw, so one question is how insights from such a wide variety of academic disciplines are brought together. In some cases, important methodological or terminological differences have been ignored or interpreted away. In other cases, the literary devices to bring together different approaches might involve the familiar technique of deploying metaphor or analogy. In others, there will be some underlying notion of progress, where early contributions are seen to be offering valid but partial understandings, which can be combined to produce a fuller knowledge of all the dimensions involved. In others still, a radical "leap", or paradigm shift, seems to be promised, which will make earlier concerns irrelevant. No doubt we could also identify all the processes of "writing"

in Derrida's terms.

Of course, the same goes for this work. I have also had to prioritise among the components of academic work, and it will be clear that I have not developed a major commitment to specific feminist politics but, instead, I focus on understanding feminist analysis, on the "episto-onto" dimensions. Barad (2011) herself says this is the important issue for feminism. I think that the extraordinary general implications of the work, especially in Kirby (2011), also follows from this emphasis: Kirby is prepared to accept that her general approach makes some specific gender politics rather arbitrary. In another example, Derrida (1991f) addresses some of the implications for specific gender politics in Levinas's work, in seeing sexual difference as secondary and suspects that Levinas's "neutrality" is really a denial of gender positionality. The issue is centrally addressed in Ziarek (2001a) but seen as less relevant in Barad (2007), who is more concerned to develop Levinas's work into a general politics of otherness.

I became interested in Barad's work initially because I wanted to explore diffraction as a method, and I quickly realised that arguments in the whole work were important. I found problems, although these may not be terminal, of course. I rely on the conventions of academic authority mentioned above, to support my arguments, fully aware that those conventions might lead to critique of this work too. Such critique would be welcome.

CHAPTER 1

THE QUANTUM WORLD

Introduction

The wider impact of Barad's work derives from her argument that quantum theory, or a particular classic version of it, is of central ontological, epistemological, and ethical relevance to social, political, and biological fields. I have used "quantum theory" as a general term for explorations of the quantum world. Specifically, there is an argument that it offers a new view of "Nature" and her relations with humans that will have critical repercussions for the usual views found in other disciplines. Conventional fixed divisions between men and women, along with many accompanying binary divisions, like those between nature and culture, will be radically undermined. It will mean that gender politics and other forms of biopolitics can claim to have a firm theoretical base and not be dependent upon political or ethical commitments alone.

It is essential to see how Barad's arguments develop in this field. This is particularly difficult for non-specialists of course, and I felt much more at ease with Barad's extended arguments in more familiar fields in the later chapters. However, we are obliged to do what we can to grasp some of the debates in quantum theory if we want to fully explore Barad's arguments.

Barad, Böhr and quantum theory

The main book (Barad 2007) offers an account of how Barad has developed more general and extensive concepts from the work of Niels Böhr, the subject of her doctoral thesis and her "interlocutor over the years" (2007, xi). Böhr, and others, including Einstein, Heisenberg, and Schrödinger, pursued some extraordinary revelations produced by investigating the quantum world in the inter-war period in Europe. Barad summarises some of the key experiments. The findings showed an immediate alarming indeterminacy. Such indeterminacy had already been discovered in light, but it was now being found in matter as well. When

guiding streams of electrons through a screen with two slits in it, cut at suitable distances apart, and recording the results on the other side, the entities behaved as if they were separate particles and produced a characteristic "bar" pattern, a normal distribution of results. However, these bars were themselves arranged in a pattern of alternating high- and low-intensity impacts, stripes of light and dark. This "diffraction pattern" is characteristic of a wave. Two-slit apparatuses had successfully distinguished particles and waves at the macro level but could not do this with electrons or increasingly large subatomic components.

It was necessary to eliminate any effects of human observers in the measurement process because Heisenberg apparently had suggested that the act of human observation itself produced changes in behaviour. An ingenious technical development meant that an atom passing through a choice-detector could be detected whether the observer was there or not, because it was made to emit a photon on encountering the apparatus. The results proved decisive in resolving that dispute between Böhr and Heisenberg in favour of Böhr, Barad says.

Further work followed adaptations of the classic two-slit experiments, for example by adding a recording apparatus to detect which slit the electrons or atoms passed through. Barad (2007) describes how the detection apparatus itself seems to affect the behaviour of the entities, however. With the choice-recording apparatus switched off, the individual atoms produced, as expected, particle-like responses in a distribution represented by a normal curve. When the choice-recording apparatus was switched on, though, more complex wave-like interference patterns were produced. Then the recording apparatus was switched off again, and the behaviour of the atoms seemed to revert to the particle-like state they were in before the recording apparatus was switched on. This is obviously only a simplistic summary. The results were initially seen as raising the extraordinary possibility that the second state, with the recording apparatus on, had somehow been affected, "erased" just by switching off the detecting apparatus. This view would imply that reality itself was capable of being altered by human interventions, specifically whether the recording apparatus was switched on or not.

An alternative proposition to erasure prevailed after further work and careful observation which suggested that the original normal curve distribution had not disappeared but was preserved, or rather recreated as one component in the more complex interference patterns seemingly produced by the recording apparatus. This finding was equally astounding—

each state of the system contains the others, including past and future states, just as fragments of an original holographic plate still retain the whole image (to use Kirby's 2011 useful metaphor).

Barad insists we take these findings as radically disturbing conventional explanations and conceptions, especially of time. She says the different patterns, normal curve and then interference pattern, are not separate events fixed into separate time intervals. Early patterns are not lost forever in some fixed past. Nor are they just reproduced as the same in subsequent events, in some circular process. Later events show the persistence of past events, and, similarly, past events have the possibility of future ones already present in them We can detect in any one actual state the possibilities and potentials of a non-empirical level of reality transcending the conventional linear track of separate states in space and time. We can also see firm experimental support for Böhr's contention that different possibilities are actualised, made concrete, by different laboratory set-ups or apparatuses. The queerness of the quantum world is confirmed by both theory and observation.

Barad (2007) explains the actual experiments with considerable skill, and it is easy to be convinced by her exposition. I can now see why some implications follow. The significance of setting a necessary boundary to apparatuses, for example, is crucial in that those experiments in the laboratory operated in an already confined context. The apparatus is obviously shielded from what might be termed extraneous effects in order to get clear results. Additions to the original two-slit apparatus, like the photoreceptors, the detection devices that are switched on or off, are made in equally carefully controlled conditions. Other boundaries are more problematic, however, and the boundary problem in general persists as we shall see.

The notion of an apparatus resolving indeterminacy also accounts for any apparent individual effects of experimenters or observers. In a more understandable classical example, Barad examines the decisive Stern-Gerlach experiments well described in Friedrichs (2003), which she summarises. It looked at first as if only the presence of Stern himself could make the apparatus work. This was resolved eventually by noting that Stern's cigars emitted sulphur particles which combined with the silver molecules on the recording plate and that made it easier to track the beams. The experiment itself was crucial to quantum theory in vindicating Böhr who had been dismissed earlier by Stern and a colleague: "'If this nonsense of Bohr should in the end prove to be right, we will quit

physics!'". After the experiments were accurately assessed and repeated, Gerlach sent a telegram to Stern saying "'Böhr is right after all'" (Friedrichs 2003). The experiment was crucial in developing applications and technologies based on quantum theory, Friedrichs argues. Barad (2007) also chooses this example to introduce demographic factors into the notion of an apparatus: Stern was precariously employed and could only afford cheap cigars at the time. However, this is the only venture in what looks like a very preliminary sociology.

Further demonstrations of quantum weirdness were to follow. Barad (2008b) discusses the famous example of Schrödinger's cat paradox to explain and popularise her case. The article seems to have been based on a talk she gave in 2004, and I read it quite late on, which might evoke all sorts of Derridavian speculations about how pasts, presents and futures are interlinked, although my own preference is to see this as a confirmation that publication dates and inefficient search strategies are unreliable as ways to chart an intellectual career. The 2008b article explains the cat paradox in terms of entanglement, seeing the cat, the potentially decaying atom, the acid, and the observation of the results as linked in an overall "phenomenon", with no real determinate meaning to be given to words like "cat" or "atom" until the experimental setup makes cuts. It would be an interesting experiment to place human beings in actual Schrödinger boxes so that those who survived could tell us what an entangled state feels like. However, the boundary problem also emerges here because Barad says that the phenomenon "includes much more than we could ever draw in a diagram… the entangled and enfolded sets of apparatuses of bodily production of all the beings and devices relevant to this example" (171), presumably *ad infinitum*.

Some popular explanations of the paradox are rejected. The cat cannot simply be in a state where it is both dead and alive, or neither, because those terms have been defined as mutually exclusive—but so have many other binaries that Barad is happy to reject including divisions between organic and inorganic. Similarly, the cat cannot be seen to have an existence "smeared" between alive and dead states, which Schrödinger's wave equation would suggest. Barad seems to be implying that "entanglement" and "superposition" do not mean a general blurred indeterminacy, but the alternation of definite states. The whole vexed issue of how quantum states turn into macro states is involved but not discussed.

These are interesting objections to alternative explanations. First, they show that thought experiments can be "made to work" by altering or specifying definitions of terms, a less rigorous procedure than patiently adjusting physical components of experiments until the right results are recorded. The creative role of the thought experiment has clearly been important in classical physics too, as Schrader (2012) argues in her discussion of Maxwell's Demon. Schrader uses the discussion to introduce arguments that the constructive powers of human knowledge have never been easy to eliminate as a factor in scientific explanation. This point recurs in Baggott (2020) on quantum theory. In both cases, there are explanations that are anti-realist, grounded in human knowledge and its organisation, including probabilistic accounts. As elsewhere, the suspicion also arises that common meanings of terms are being swapped inconsistently with scientific ones, at least in some accounts.

Second, it seems that Baradian entanglement can produce alternations of exclusive binary states, like dead and alive. If this is so it is surely worth pointing out that binary divisions can be produced by real material processes too. This would be an insight like the one revealed by Deleuze when questioned by Parnet about the persistence of binary divisions in his own work (Deleuze and Parnet 1987). In essence, Deleuze argued that this was not a sign of terminological inconsistency on his part since some binary divisions were produced by mechanisms at work at the virtual level itself, that the virtual actualised itself in binaries sometimes. Of course, this does not mean that binary divisions are privileged versions of reality. They are still only possibilities from a larger potential—but they are not just arbitrarily political either. Binary divisions are often rejected outright in Barad's work where they are usually seen as phallogocentric, such as when discussing highly variable, even indeterminate, queer sexuality instead of conventional heteronormative binary identities. However, we may be able no longer to condemn all actualised binary divisions as the result of artificial political processes, as deliberate distortions of reality, or as infallible signs of phallogocentrism. The chronic problem in any two-level explanation appears, identifying just what in the actual is produced by material reality itself and what is produced by political action, and whether the distinction can be made consistently.

Barad (2008b) also explains further what she means by the "material-discursive". The basis for the connection of the terms seems to be that both discourses and material processes reveal meaning as they develop over time, and that this development can guide both language and

practical modifications of matter. However, I saw a problem. Although discourses do work in the syntagmatic dimension, by revealing meaning over time, say in a narrative, they also have additional paradigmatic qualities, to use the classic terms, where signs are given meaning by being put into diachronic sets suggesting links with other allied terms. The specific processes are found in deliberate metaphor or metonym, but nothing stops the signifier sliding still further. The question is whether material developments have an equivalent signifying capacity outside of human language.

Barad's later work covers more recent developments in quantum theory termed Quantum Field Theory (QFT). She makes the arguments as clear as possible for non-specialists, especially in Barad (2017), with the aid of useful diagrams, and she supplies additional reading, but there is still no practicable independent way for non-specialists to assess her conclusions, of course. She discusses "superposition", the apparent ability of particles to be in two places at once, but now referring to locations in time as well as space, which means that the usual concepts both of Cartesian space and linear time are radically "troubled".

The later work is also described, for example, in Barad (n.d.) or Barad (2016). It turns on discussions of the void or vacuum and how the quantum version radicalises the conventional implications of nothingness. It seems the quantum vacuum features vibrations which produce a plethora of subatomic particles, both actual and virtual, which, in principle, continue to interact *ad infinitum*. We have known since Einstein that energy, vibrations, can turn into mass and vice versa, although here the energy seems originary. Barad amends and politicises this theory to further dispute conventional understandings—a quantum vacuum produces material by "self-touching intra-action" (2017, 79). She goes on to argue that touching is a universal constituent of mattering, which clearly extends to human touching and implications for self-other relations as stressed by feminism, partly as a rejection of the distanced objectivity of vision.

Overall, in summary, all sorts of other bizarre qualities of atoms and particles were discovered by exploring the quantum world. Again, we can only attempt to partially describe these in ordinary language, which might lend an unfortunately misleading "realist idiom" to Barad's accounts (Pinch 2011), or an anthropomorphic or even a New Age one as we shall see. Initially, particles apparently could affect each other even if subsequently widely separated, so that if the state of one was altered, the other one would immediately adopt a corresponding "complementary"

equivalent, implying some "entanglement" or "superposition". Earlier experiments had dispelled the notion, at least temporarily, that such characteristics were the result of measurement error or any observer uncertainty as we saw: they were ontologically real effects. Barad also argues that Böhrian conceptions of entanglement removed the need for any additional explanations of "spooky action at a distance" or communication operating faster than the speed of light.

Barad especially values Böhr's view that we had to recast our understanding of the basic units of matter. These could no longer be thought of as simple particles acted upon by simple forces, detected as "objective" mechanistic behaviour, with measurement as a separate cognitive activity. This argument goes all the way up to social relations as we shall see. In particular, "[the term] 'individual' is ontologically and semantically indeterminate in the absence of an apparatus that resolves the inherent indeterminacy" (Barad 2007, 316).

Instead, Böhr uses the term "phenomenon" as the basic unit, one where real particles are necessarily intertwined with human understandings, and with a definitional or boundary role necessarily exercised by experimental apparatus itself. That was to include conceptual apparatuses as well as physical mechanical ones. The term "phenomenon" still has associations with consciousness and philosophical phenomenology, but, presumably, Böhr did not want to positively favour idealism. It has not disappeared as a possibility, though, as in discussions of thought experiments above. Barad leaves no room for classic phenomenology, and even cites Derrida's (1991b) critique of Husserl's idealist notion of time (Barad 2007, 179). Derrida, Levinas and Merleau-Ponty all seem to have broken with Husserl's phenomenology via a form of phenomenological bracketing that argues that an "outside" is necessarily implied in phenomenological accounts of consciousness. It is not clear whether Barad uses the same techniques to clarify Böhr.

It is possible to intervene in this necessarily intertwined reality for the purposes of understanding it, and maybe even manipulating it. This is done by the process of making a cut in phenomena, taking a particular approach, constructing a particular apparatus. This cutting has the dual effect of necessarily including some characteristics, relating them together in the interests of understanding or manipulation, but without assuming that those relations are the only possible ones, and without permanently excluding any others. Cuts like this therefore offer "cutting-together-apart".

Various "agents" perform these cuts, and Barad wants to insist that they are not just human agents. Nor are they just the familiar nonhumans, although both machines and animals are of particular interest, as we shall see. The whole of matter is agential for Barad. The actual or empirical world is produced as a result of universal agential cuts, a process of realisation or actualisation from the range of possibilities offered at the virtual level (to put it in Deleuzian terms). This might easily suggest an underlying vitalism for those predisposed to take that view. Post-humanism could mean, in effect, transferring over to "Nature", or even to the universe, all the qualities that are still required in responsible knowledge production—reason, conscious reflection, interrogating meaning, creative thinking. Humans are reduced in the process to parts of the world, for Barad, mere apparatuses, agents in the world's reconfiguring "the lifeblood of the universe in its ongoing recreation" (2008b, 174). This underpins the argument that conceptual structures are apparatuses, the same as physical ones, for example.

The vexed issue of human exceptionalism reappears in Chapters 2 and 3. However, there might be one way in which humans are clearly exceptional even for Barad: they seem to bear ethical and political responsibilities for what they do, in a way in which starfish or slime moulds may not. Barad needs to explain ethical and political dimensions of conduct in ways which do not reinforce human exceptionalism, and she does this eventually by incorporating the work of Levinas on ethics, in an interestingly "materialised" way. The fundamental argument is that the commitment to others is the basis of ethics. This is not just an option found in human consciousness or culture but is "outside", with an actual material or bodily source. It is "incarnated" to cite a phrase that Barad uses several times. The issue appears again in Chapter 6.

Amidst the gripping detail and powerful argument in Barad, we are persuaded to think that quantum weirdness applies to normal material reality as we know it, affecting space and time at the macro level too, that quantum features like "'relational différancing' [goes] all the way down" (Barad 2017, 66). We have compelling statements like "whereas classical mechanics and geometrical optics are... useful under some circumstances… quantum mechanics… can account for the phenomena at all stages" (2007, 85), which is actually qualified by saying quantum mechanics accounts for behaviour at a very wide range of light frequencies "as a [mathematical] formalism". The obvious objection is that the quantum world occupies such a miniscule part of reality that its weirdness disappears, collapses, decoheres, gets cancelled out by millions of

interactions, as we scale up to the macro level. There are, however, intriguing examples where quantum effects seem to persist in important macro biological systems (Al-Khalili, n.d.).

Barad (2001) argues that scale is inextricably entangled with political and social considerations. Barad (2017) says the socially constructed conventional notions of scale are artificially limiting and can even be considered as "but a marker of an imperialist and colonising worldview' (2017, 61). Operating at the abstract level of quantum formalism and challenging conventional units will permit a "politics of possibilities" as well as sinister military applications, as we see in Chapter 4 especially.

Overall, Barad prefers to say the effects of scale are produced by "agential enfolding" (2007, 246), a feature of universal configuring. Of course, phenomena exist at different scales, and these are practically important in developing various engineering specialisms, but scale seems not to be theoretically or formally important. For example, political, technical, and social elements are less important than the abstract formalism that permits transferring insights across scales, as in the development of quantum theory into nuclear weaponry in Barad (2017). However, not everyone agrees, as Baggott (2020) makes clear, and Barad (in Jeuleskjaer and Schwennesen, 2012, 18), sees the need to discuss her views, at least with fellow physicists. She is not saying that scale does not matter, but that "the way scales are produced has to be part of the conversation" (48), and that scale is certainly not simple because there are assumptions at play. She returns to the issue of scale as a matter of "nested" structures as we shall see. Later, I also offer the view, briefly, that there is something different and emergent once we get on to human interaction at the social level, which is more than just a change of scale from individuals or dyads.

Materialising Böhr

One criticism of Böhr echoes familiar problems in social sciences too. Humans are included in the apparatus as observers and measurers, and as interpreters and validators, and Böhr is suspected of residual humanism as a result. The implication is that humans are still necessarily involved as the only uniquely creative subjects with knowledge-producing consciousness. One problem arises immediately: as a contributor to the debate (not covered in Barad's account) put it:

> What exactly qualifies some physical systems to play the role of "measurer"? Was the wave function of the world waiting to jump [into a detectable macro form] for thousands of millions of years until a single-celled living creature appeared? Or did it have to wait a little longer, for some better qualified system… with a PhD? (Henderson 2016)

This remark was originally aimed at a different form of realism, but it pertains to Barad too. She does not address this point directly, although it might be possible to construct her response from her arguments about agential realism. Barad rejects classic humanism via poststructuralism, first via Foucault, and then Derrida (suspending his own refusal to be so labelled). The argument has usually taken the form of making a "linguistic turn" so that the individual subject disappears into textuality, specifically discourse or writing. Why Foucault and Derrida specifically are chosen is unclear, but both were already widely discussed in feminist circles, and in "queer work". Derrida also becomes useful for things like deconstructing conventional time via "haunting". I still think the question above is a relevant one, however, whether the measurer is a classic Cartesian subject, or a vector of a discourse.

As many have discovered, poststructuralism's critique is not easily contained, and there are implications that notions of material reality, even the accounts of it found in physics, are equally discursive even if more formalised or explicit (Foucault 1974). Consequently, Barad needs to further materialise both Foucault and Derrida, as well as Böhr, so that producing text itself becomes a material activity. Both writers acknowledge that texts can become expressed as practice, but this is not enough, and what we require is a notion of the fully "material-discursive" to finally banish any "anthropocentrist and representationalist assumptions" (2007, 27). We can get that by turning to Böhr and taking his notion of non-human apparatuses as agents to extend the one in Foucault, for example.

One particularly obvious problem still emerges in Barad's work and in all academic work offering poststructural analysis. The individual author might be an ideological construct, but individual authorship persists. An "author function" (Foucault 1979a) is required not only to stabilise possible readings, but to meet organisational and legal requirements for individual reward: doctoral students and those proposing publication must assert that they are creative, individual authors, especially if they claim copyright. At the theoretical level, it is difficult to explain innovation or creative developments without specifying some

agent able to develop the constraints of structured discourses, even if these might be collective agents or spokespersons for them.

One side of the dilemma for Barad appears in phrases saying that deconstruction is not a human method or technique, but rather "what the text does, what matter does, how mattering performs itself" (Barad 2010, 268). We must not "wrongly attribute agency to reified notions called Culture, Power, Discourse, et cetera". Ideas are not just in her head—"they are specific ongoing reconfigurings of the world in its iterative intra-activity… threaded through 'me' and 'me' through them" (Jeuleskjaer and Schwennesen 2012, 23). Specifically, it would be wrong to see her own work as a narrative produced by a conventional subject "since this position is counter to diffracting. There is no I that exists outside the diffraction pattern, observing it, telling its story. In an important sense, this story in its ongoing (re)patterning is (re)(con)figuring me" (2014, 181). More generally, "all 'selves' are not themselves but rather the iterative intra-activity of all matter of time-beings… dispersed/diffracted through being and time" (Barad 2017, 80). For that matter, human memory is not a feature of human consciousness but is materialised, embedded or sedimented in objects such as landscapes.

The return of the repressed author appears most clearly in a section which uses first person pronouns: "My project departs from science studies approaches that place science at a remove (2007, 247) ... I do not merely reflect on science, *I engage in the practice of science while addressing entangled questions about the nature of scientific practice* (original emphasis) ... I return... I begin... I started... I argue... I propose... I present" (Barad 2007, 248). "I mean to cajole" (249). "[I]…get my hands dirty and experiment with different differences" (in Kleinman 2012, 78). Earlier: "generally speaking, the results don't simply announce themselves; rather, one has to analyse the data in some way" (2007, 312). Barad says she has tested her diffractive methodology herself "by challenging myself to make good on the claim that I could derive new results in this way" (2011, 446).

Barad also seems to favour a personal kind of human ethical responsibility for agency, as we shall see, but an emphasis on texts or material configurings might well absolve human individuals from any personal responsibility. We discuss this again in Chapter 6, where other authors have also noticed this "tension" or "paradox" in a general approach which offers an ontology extended to non-humans while drawing on and discussing human ethics. Olkowski (2016), in a particularly

thorough critique, says that a completely materialist account of human beings also makes it difficult to explain the conduct of science itself in so far as it operates with specific commitments to objective understanding of, not just responsiveness to, the material world. This preserves a notion of objectivity as a valid description of the world, of course, although Barad cites Böhr's conception instead. This appears to be a version of a correspondence theory of truth where unambiguous marks are made independently by apparatuses and these are communicated to others and reproduced in subsequent experiments.

Just as poststructuralism needs further work to materialise it, so does the notion of agency as both textual and individual. Barad develops agential realism and intra-action as "nondeterministic alternative dynamics". Elsewhere, the concepts "[materialised] performativity" and "enactment" have the same goal, specifically extending or refuting Butler, as we shall see in Chapter 4, and offering "a kind of questioning and unsettling of representationalist politics that was very much alive in feminist work". Kirby, Schrader and Ziarek have also played an important role in materialising Derrida and Levinas, but in different ways. At some stage(s), Böhr was read diffractively with those subsequent texts.

Barad draws upon Böhr, but also re-reads him, via a process of elaborated "materialisation". One way to do this, initially without leaving physics, involves showing ways in which metaphysical concepts, originally deployed in thought experiments found in Böhr's debates with his contemporaries, including Einstein, could be tested by empirical measurement. John Bell took propositions that were thought of as "merely philosophical" (253) and operationalised them in statistical models and laboratory experiments. Barad describes this as having "provided an empirical handle for resolving some of the most metaphysical issues". I gather that Bell developed a statistical model, listed all the probabilities produced by the "hidden variables" approaches and cited empirical observations which decisively showed more variation than those models predicted. Barad (2007, 291–2) claims that:

> the empirical tests indicate that the [specific rival] EPR hypothesis is wrong... there is empirical evidence for the existence of a different metaphysics than the one underlying Newtonian mechanics... no mere philosophical prejudice but an empirical fact... it is no longer possible to embrace the metaphysics of individualism (as in classical Physics).

However, whether Bell would have supported Barad's metaphysics specifically is unclear—Baggott (2020) maintains that he was not a realist.