Article

Anthropological Theory
2015, Vol. 15(4) 407–433

DOI: 10.1177/1463499615615739
ant.sagepub.com
SAGE

Unifying minor sciences and minor literatures: Reproduction and revolution in quantum consciousness as a model for the anthropology of science

Matthew Wolf-Meyer
Binghamton University, USA

Chris Cochran
University of California, Santa Cruz, USA

Abstract
In this paper, we explore the possibility of using Gilles Deleuze and Felix Guattari's theories of minor science and literature to examine the role of marginalized sciences, particularly in the United States. We suggest that by combining Deleuze and Guattari's work on minor sciences and minor literatures that the framework for an anthropology of science which takes alternative and marginalized sciences seriously can be established. To elucidate this model of inquiry, we focus on three aspects defined by Deleuze and Guattari: the political relationship of minor to dominant sciences, the role of science in the state, and the ways that minor sciences reconfigure dominant sciences. As a case study, we examine the science of 'quantum consciousness' in the United States. Quantum consciousness research proposes to replace dominant metaphysics in Western science, and its minority status is perpetuated by the power structures that draw on dominant sciences' relationships to the state and knowledge production.

Keywords
Gilles Deleuze, Felix Guattari, expertise, minority, quantum consciousness, quantum physics, science, the state

Corresponding author:
Matthew Wolf-Meyer, Department of Anthropology, Science 1, 4400 Vestal Parkway, Binghamton University, Binghamton, NY 13905, USA.
Email: matthew.wolf.meyer@gmail.com

In this article, we provide a model of scientific knowledge production and change based on the work of Gilles Deleuze and Felix Guattari, in which we unify two strains of their philosophical project on 'minor science' and 'minor literature' (Deleuze and Guattari, 1986 [1975], 1987 [1980]). In doing so, we stress the power relations in the development and establishment of dominant and minor sciences. This model might provide an alternative to Kuhn's conception of scientific paradigm changes (1970 [1962]) for the purpose of ethnographic and historiographic studies of scientific knowledge practices, with particular attention to the experiential qualities of being a minor scientist in the context of the capitalist infrastructure of contemporary scientific practice.

Kuhn's conception of paradigm shifts is complicated, and scholars have pointed to how in his work there are a variety of ways that a scientific paradigm might be transformed and what this transformation means. Margaret Masterman (1970) identifies 21 different usages of 'paradigm' in Kuhn's work, and categorizes them in three ways: the metaphysical, the sociological, and construct paradigms. Metaphysical paradigms refer to unquestioned presuppositions (Masterman, 1970: 65) among a group of people who see themselves working on the same scientific problem. The 'sociological' refers to beliefs among divisions within that broader group, for example the difference between how cultural and biological anthropologists conceptualize human nature, what Douglas Eckberg and Lester Hill refer to as a 'disciplinary matrix' (Eckberg and Hill, 1979: 926). Finally, the 'construct' is analogous to what Kuhn refers to as the 'exemplar', which embodies 'the concrete problem-solutions that students encounter from the start of their scientific education, whether in laboratories, or examinations, or at the ends of chapters in science texts' (Kuhn, 1970 [1962]: 187). These three categories nest, such that the highest, most determinative level is that of the metaphysical, the sociological comes next, and the construct lies at the bottom, being the most everyday and practical use of a science. A science is applied to a variety of problems through the generalization of exemplars – but this is also where a science may begin to fracture in its ability to maintain a metaphysical paradigm, particularly when exemplars or constructs fail to explain new problems. When this occurs, a revolution is in order, necessitating changes from either the bottom up or the top down.

One of the problems with Kuhn's conception of the scientific paradigm is that it sees scientific change as internally determined: a science has its own system of belief, its own communities that have a shared set of assumptions, and its own kinds of problems it tends to solve, all of which leave the science largely unchallenged in its assumptions. New problems may emerge to be solved, but a science may also be declared by its practitioners as irrelevant to a particular problem, thereby preserving the science's paradigm; because of the diversity of contemporary sciences, any particular problem can always be shunted to another respectable science. But this variety of sciences allows for the possibility of an external force leading to the shift of dominant scientific paradigms; that is, the very diversity that

allows for the preservation of dominant scientific metaphysical paradigms produces the ground for external challenges to those paradigms. In this article, drawing on Deleuze and Guattari's work on minor science and literature, which they held apart, we are forwarding a conception of science and scientific change that stresses power and force between and within scientific disciplines (Latour, 1999; Latour and Woolgar, 1986 [1979]) and between science and non-science – or between scientists and 'weirdos'. Scientific paradigms may change because of the insufficiency of an exemplar to solve emergent problems, but they may also change due to external pressures of minor sciences that seek to replace the metaphysical assumptions of a science. In the case of quantum consciousness, researchers tactically exploit philosophical conundrums in dominant sciences, thereby providing minor scientists with an opening to call into questions the metaphysical assumptions of dominant sciences. These conundrums include the measurement problem in quantum mechanics (popularized in the figure of Schrodinger's cat) and the mind-body problem, that is, how the psyche can arise from biological material, both of which raise – at least for quantum consciousness adherents – the possibility that dominant sciences are fundamentally, metaphysically flawed. The minor science of quantum consciousness provides us with a case to work through in order to elaborate the relationships between minor science and dominant science, and how a science might change dependent upon external forces. Secondarily, this case also provides us with an opportunity to elaborate the synthetic qualities of minor sciences and minor literatures as a model for the development of an anthropology of science that moves beyond internal paradigm shifts and toward theories that privilege ongoing interplay and tension – what Deleuze and Guattari refer to as 'enrichment' – between those sciences and scientists in power and those who remain resolutely minor.

Quantum consciousness is a science that seeks to demonstrate that the foundations of consciousness are quantum physical rather than biological. Quantum consciousness scientists argue that consciousness cannot be adequately explained in terms of concepts derived only from neuroscience and biology. Instead, they suppose that a scientific explanation of consciousness will require the discovery of a mechanism that allows certain special features of quantum mechanics to give rise to human consciousness in the brain. From this perspective, consciousness is universal to matter, and what requires explanation is the mechanism by which universal consciousness is given the particular form that we humans experience. Discovery of such a mechanism would have to integrate knowledge from many scientific fields, including quantum mechanics, neuroscience, biology, and psychiatry. Meanwhile, quantum consciousness scientists also draw guidance from spiritual and contemplative knowledge of the mind derived from the practice of meditation, yoga, shamanism, or psychoanalysis. While most eschew 'religion', some seek understanding of revelation and miracle in the combination of quantum physics and Holy Scripture. Since so many forms of knowledge are understood as relevant to its quest, quantum consciousness is more inclusive than most sciences, and often

creates forums where non-academics participate alongside university professors and researchers to share evidence, experiences, and theories. It is this openness and hybridity that makes quantum consciousness such a dynamic form of knowledge production; it seeks to include nearly everyone and everything in its goal of understanding consciousness.

In this article, we extend our analysis beyond quantum consciousness to think about the ways that other 'fringe' or marginal sciences can be understood as minor sciences (Hess, 1993) and what this means for the scientists who claim the minor science as a discipline, and also how the existence of these sciences can lead to changes in dominant sciences.[1] Before we turn to our case study of contemporary quantum consciousness scientists, we elaborate Deleuze and Guattari's concepts of minor science and literature, and show how they complement each other, providing a framework for conceptualizing dominant and minor sciences and the possibilities for their transformations. This discussion draws on Deleuze and Guattari's collaborative philosophical project, which spans *Anti-Oedipus* (1983 [1972]), *A Thousand Plateaus* (1987 [1980]), *Kafka: Toward a Minor Literature* (1986 [1975]), and *What Is Philosophy?* (1996 [1991]). We draw from these texts – primarily *A Thousand Plateaus* and *Kafka* – to elucidate our methodology for understanding the features and forces of minor sciences.

Reproductive and rupturing sciences

Anthropologies of science have largely fallen into two theoretical camps: those that restrain themselves to the 'citadel' of science and those who trace the influences, conceptions, and practices of science out into society more generally. This distinction, one made by Emily Martin (1997), sees some anthropologists restricting themselves to laboratories in isolation, 'citadels', and other anthropologists as showing how science is 'rhizomatic' or a 'string figure'. The 'rhizomatic' and 'string figure' models see science as existing in multiple parallel sites where the same science is practiced with variation, or as always deeply embedded in society and cultural expectations, providing a steady flow between science and non-science. Regardless of which model is embraced, Martin is interested in how scientific practice is culturally influenced, and that the methodological divisions we make often 'purify' science of its cultural content – unless we explicitly place the practice of science in society, whether in a laboratory, clinic, or a less defined space. For those anthropologists and ethnographers who have focused on the practice of science in its citadels, the interpretive, interpersonal, and internal logics of science are key (Knorr-Cetina, 1999; Latour and Woolgar, 1986 [1979]; Lynch, 1985); power, in these studies, is often less apparent than in those that followed in their wake, which more explicitly addressed relations between science and society and within scientific practice. The turn to power relations in science – which minor sciences more robustly capture – has depended upon moving science out of the laboratory and into the worlds that it creates, maintains, and challenges. This has been

especially apparent in the ethnographic study of genomics, as the communities represented by new genetic knowledge contest and collaborate with scientists, clinicians, policy makers, and government and medical institutions (Montoya, 2011; Taussig, 2009; Taussig et al., 2003; Lee et al., 2008). But other sciences are equally distributed in their social situations and similarly complicate the idea of science divorced from society and social pressures.

The social studies of science have a long history of being concerned with how science changes, often cast as a result of inside pressures. This is most evident in the work of Kuhn and his successors, whose scholarship focused on the progressive transformation of one scientific paradigm to another, a model of scientific development that scientists themselves have become increasingly aware of and conversant in (Marks, 2009). In these paradigm shifts, dramatic changes occur to the metaphysical presuppositions of scientific fields, as in the shift from Newton's to Einstein's conceptions of the universe, which leads to transformations in the sociological and construct level of dominant paradigms. More recent studies of science have stressed how science operates in its everyday contexts – not as transforming, but as reproducing itself through the daily practice of laboratory workers, bench scientists, and administrators (Knorr-Cetina, 1999; Latour and Woolgar, 1986 [1979]; Lynch, 1985; Martin, 1994; Taussig, 2009). Whereas the older histories of science stressed the dramatic tensions around the shattering and replacement of paradigms, this more recent work has focused upon the banality of everyday science, and the slow production of scientific knowledge. With this attention to the everyday practice of science, paradigm shifts are more difficult to locate – if they occur at all – buried in the everyday activities of scientists and their staff. What minor science helps to show is that new scientific paradigms may not announce themselves so much as coexist with dominant scientific pursuits in ongoing and subtle ways. In the case of the science of quantum consciousness, it does announce itself as a new paradigm, but is not necessarily addressed as such by those in power.

We mention these methodological and theoretical trends in the social study of science to contextualize our efforts in thinking through the utility of minor sciences as a model: rather than mundane and everyday, and instead of crisis producing, minor sciences are something else entirely. They exist at the fringes of 'dominant', 'major', or 'royal' sciences, and reconstitute them through the always-outsider status of minor scientists and minor sciences.[2] We have four goals in this article: 1) to synthesize Deleuze and Guattari's work on minor science and minor literature into a unified theoretical framework to conceptualize science, 2) to demonstrate how minor sciences relate to dominant sciences and may lead to scientific changes, 3) to elucidate the qualities that reproduce minor sciences as minor sciences, and 4) to demonstrate how the model of minor science can add to the anthropology of science. We turn first to elaborating the idea of minor science, and then turn to a case study of quantum consciousness scientists to elaborate how this framework works and what it helps to show.

Defining minor science against the state

Deleuze and Guattari give us very little through which to understand what they refer to as 'minor science' in *A Thousand Plateaus*. They begin with this figuration:

> [T]he opposition between minor sciences and major sciences: for example, the tendency of the broken line to become a curve, a whole operative geometry of the trait and movement, a pragmatic science of placings-in-variation that operates in a different manner than the royal or major science of Euclid's invariants and travels a long history of suspicion and even repression. (Deleuze and Guattari, 1987 [1980]: 109)

If dominant sciences are known through their use of Kuhnian exemplars to solve the puzzles they pose for themselves, minor sciences depend upon a less apparently logical relationship between metaphysical presumptions and concrete problems. Instead of transforming a 'broken line' back into a line, they are liable to cast it as a curved line – at least from the perspective of dominant sciences; in other words, from the position of dominant scientists, minor scientists are liable to be construed as 'weirdos' and 'New Agers'. But the key of minor sciences is in the last clause offered in this description – they are suspicious, and often repressed. They offer something that is at once generative, but also dangerous. And Deleuze and Guattari acknowledge this, arguing that 'Minor science is continually enriching major science, communicating its intuitions to it, its ways of proceeding, its itinerancy, its sense of and taste for matter, singularity, variation, intuitionist geometry and the numbering number' (Deleuze and Guattari, 1987 [1980]: 485). Moreover, they argue that 'Major science has a perpetual need for the inspiration of the minor; but the minor would be nothing if it did not confront and conform to the highest scientific requirements' (Deleuze and Guattari, 1987 [1980]: 486).

Minor science can be seen as necessary to dominant science – it is inspirational, potentially in a negative fashion by way of critique, and it demonstrates the power and authority of major science, borrowing its techniques of knowledge production and expertise, particularly through the use of scientific language, established methodologies, and generic forms. Moreover, minor sciences provide for dominant sciences what they themselves cannot produce – knowledge that lies outside of the purview of the disciplines. Deleuze and Guattari explain this system of appropriation: '[T]his nomad science is continually "barred," inhibited, or banned by the demands and conditions of State science... State science continually imposes its form of sovereignty on the inventions of nomad science. State science retains of nomad science only what it can appropriate' (Deleuze and Guattari, 1987 [1980]: 362). Throughout Deleuze and Guattari's work, the figure of the nomad exists as a counterpoint to the state, whether it is embodied in minor scientists, landless militias, or the more anthropological figure of the stateless society. Moreover, central to Deleuze and Guattari's conception of minor sciences and literatures is the interrelated processes of the state and capitalism; minoritarian science and literature depend upon the state and its authorizing ability to endow some sciences with

dominant status whence minor scientists can identify their differences and exist as nomadic experts.

For Deleuze and Guattari, the state was necessary for the advent of capitalism, but capitalism, in turn, has superseded the state. In its infancy, the state depends on isolating labor, from which it extracts rent and tax (Deleuze and Guattari, 1987 [1980]: 442); this accrual of wealth is isomorphic with the state's capture of scientific knowledge production, which, like labor in the strictly materialist sense, produces 'surplus' from which profit is derived. This tripartite relationship – of laborer, state and capital – leads to the invention of the nation, and thereby the inauguration of forms of modern subjectivity, as individuals see themselves as subjects of the state (Deleuze and Guattari, 1987 [1980]: 457). Taxation here should be understood as the mechanism whereby surplus is accrued by the state, but in this model it is not money but scientific knowledge useful to the state and its aims. Scientists who are taxed in this way come to be subjects of the state through their identification of worth through the science they conduct. These twin forces of taxation and subjectivization lead to the enshrining of some sciences as dominant, while others are relegated to minoritarian positions. Those that become minoritarian are those that resist or subvert attempts at 'taxation' or direct incorporation into the state; one idiom that does so is that of metaphysics, which the modern state attempts to ignore. Today, metaphysical questions are commonly understood as questions that cannot be submitted to experimental inquiry, and therefore yield no reproducible results. In demarcating kinds of knowledge production that result in surpluses for the state, those in power marginalize science that fails to contribute to its accrual of wealth – which, in the current moment, occurs as much through pharmaceutical research, medical insurance, and patents as it does through the recognition of vital scientific efforts.

Deleuze and Guattari also characterize minor sciences as nomadic sciences, which are not simply marginalized but opposed to the state. As such, the science of the state is predicated upon capitalist arrangements of labor, which in themselves necessitate specific uses of time, space, and the bodies produced through spatiotemporal formations. Dominant sciences are concerned with classification, hierarchy, and order: theories of solids and being, more than a theory of liquidity and becoming. Dominant sciences seek to produce timeless knowledge, natural laws, and universal truths, while minor sciences are sciences of time, flow, contingency, and history. This productive – or counter-productive – element is what Deleuze and Guattari identify as being the most problematic for the inclusion of minor sciences into society at large: '[I]f the State always finds it necessary to repress the nomad and minor sciences . . . it does so not because the content of these sciences is inexact or imperfect, or because of their magic or initiatory character, but because they imply a division of labor opposed to the norms of the State' (Deleuze and Guattari, 1987 [1980]: 368). Any reading of labor history in the North Atlantic (Rabinbach, 1990; Roediger and Foner, 1989; Thompson, 1980 [1963]) shows how central the control of labor is to the production of the state – which is paralleled in the state capture of science. As science moved from the drawing rooms of the elite to the laboratory spaces of

universities and corporations, it also moved closer to the heart of the state. The literature on the 20th-century history of science, from the development and everyday practices of institutions from the Salk Institute (Latour and Woolgar, 1986 [1979]) to Los Alamos (Masco, 2006), to the careers of physicists (Knorr-Cetina, 1999; Traweek, 1988) and biologists (Helmreich, 2009; Martin, 1991; Taussig, 2009), demonstrates how fundamental to scientific pursuits the state and its capital have been. Thus, any scientific practice that eschews the laboratory-ordering of knowledge production defies the 'scientific management' of labor that the capitalist state requires (Taylor, 1998 [1911]); any scientist who works otherwise is relegated to the position of the nomad – at times useful, but unsettling.

Minor sciences as contingent and subjective form

Integral to minor sciences is a different relation to objectivity, to the pursuit of knowledge and the production of scientific facts. Deleuze and Guattari characterize this difference as that between 'reproduction' and 'following'. The dominant sciences are typified in their search for the ever slightly widening of their knowledge, what construct paradigms help to solve – another carcinogen, another chemical reaction, another synthetic sugar – and in so doing they reiterate their position relative to their objects of study: the scientists are subjects, and their objects are objects. Objects are stable, and can be known in greater detail through scientific practice. In comparison, minor sciences are characterized by the act of following, by their pursuit of 'singularities'.[3] Deleuze and Guattari explain that minor science '*follows* the connections between singularities of matter and traits of expression, and lodges on the level of these connections, whether they be natural or forced' (Deleuze and Guattari, 1987 [1980]: 369, emphasis in original). Minor sciences are concerned with what constitutes a phenomenon – how an assemblage comes into being (Latour, 2005), by what means its constitution is facilitated. Thus, the minor sciences are not defined by their objects a priori, but are constituted in their relationships with processes of producing knowable objects. Minor sciences do not discover, but show how objects are invented through complex social investments, including the practice of science itself. To preface our discussion of quantum consciousness, the singularity of human consciousness is a particular problem – that is, human consciousness rather than other forms of consciousness, although they may be analogous – but its explanation depends upon a diverse and unpredictable set of bodies of knowledge, only some of which may be recognizable to dominant sciences. Singularities, here, are those immanent assemblages that become apparent and able to be acted upon through the ways of knowing that render a particular assemblage into processes or objects of inquiry. Moreover, singularities are both dormant and invented. They are dormant in that they exist prior to their assemblage, and they are invented through the process of being made visible and subject to ways of knowing – which often require the invention of new disciplines of knowledge production.

Because minor sciences are so contingent, so open to their objects, the knowledge they produce is always only 'approximate'. One might object that all sciences

are only theoretical in their knowledge production (Haraway, 1997), but from the perspective of the dominant sciences, science produces ahistorical or objective truth – they are discovering, not inventing knowledge. On the other hand, minor sciences accept the contingency of knowledge. As Deleuze and Guattari explain:

> Everything is situated in an objective zone of fluctuation that is coextensive with reality itself. However refined or rigorous, 'approximate knowledge' is still dependent upon sensitive and sensible evaluations that pose more problems than they solve: problematics is still its only mode. (Deleuze and Guattari, 1987 [1980]: 373)

Minor sciences are not dedicated to solutions. Rather, they are interested in raising questions, of posing problems that might, at times, unsettle the positions and knowledge production of the dominant sciences. This leads to their repression, their marginalization – a status through which their nomadic state is reinforced. Asking questions in itself is not enough to necessitate this marginalization of minor sciences, rather it is the other qualities of minor sciences, those that align with minor literatures, which compound the marginal status of some sciences.

To further elaborate on the qualities of minor sciences we borrow from *Kafka*, wherein Deleuze and Guattari focus on a theory of minor literature. This move, on our part, is facilitated by our understanding that science is primarily a textual practice, that it produces its own literature, both in the scientific production of journals, articles, books, and other media, but also in the establishment of canons of thought that are based on textual practice. The minority status of this literature can immediately be ascertained by a cursory examination of the hyper-specialization and diversity of scientific publications, journals that exist solely to publish the works of the minor scientists, providing them with an outlet that ensures their continued marginality and productivity.[4] In *Kafka*, Deleuze and Guattari suggest that minor literature is characterized in three ways: what they refer to as 'deterritorialization,' 'politicization', and 'collective value'. We follow Deleuze and Guattari's characterization to expand our analysis of minor science, and suggest that attention to the literary character of science opens up their theory of minor sciences for methodological elaboration.

There are three features we see as particularly amenable to further development. First, a minor science is deterritorialized, meaning it speaks from a field not its own. Instead, it stretches or bends the meanings of concepts of the field that it challenges, and often uses theories in 'incorrect' or 'unfair' ways from the point of view of the dominant science. The relationship between theory and evidence is not concretized in minor sciences insofar as the minor science's theory signifies an impasse or gap in the dominant theory and intensifies it, potentially leading to the dominant science's replacement. Secondly, and following from this first feature, minor sciences are intensely political. Through their posing of questions disruptive to dominant science, minor sciences politicize themselves through their very practice. Our final feature is that of 'bachelorhood', the structural positioning of minor sciences as isolated, nomadic, and estranged. While this seemingly external position

might marginalize minor sciences, it instead aids in the construction of their very powers as they have the potential to disrupt existing power relations between scientific fields and within dominant sciences.

Minor sciences as deterritorialized, political and bachelor

The process of deterritorialization relies upon a shared language – minor sciences, like minor literatures, are dependent upon a common discourse, although they may be describing a reality quite different from that of the dominant sciences.[5] To not participate in this common language would place the efforts of any scientist resolutely outside of the realm of recognizable science. Because of this shared language, as Deleuze and Guattari explain, the dominant sciences are always open to the possibility of their deterritorialization – because of their shared language, the potential for their unsettling is always present: 'Even when major, a language is open to an intensive utilization that makes it take flight along creative lines of escape which, no matter how slowly, no matter how cautiously, can form an absolute deterritorialization' (Deleuze and Guattari, 1986 [1975]: 26). What this means in practical terms is that the language of the major sciences can become subverted into referring to phenomena entirely different from what the original intent was, a reassignment that works against the interest of the dominant sciences. Paradigm shifts, in this model, need not only come from within a science, but can be precipitated because the very language of science becomes unsettled, the language of science comes to describe something other than it was originally intended for. The language of the sciences is always the subject of concern, in need of policing, and intensely political.

This is how Deleuze and Guattari characterize the politicization of minor literatures:

> everything in [minor literatures] is political. In major literatures . . . the individual concern (familial, marital, and so on) joins with other no less individual concerns, the social milieu serving as a mere environment or background. . . . Minor literature is completely different; its cramped space forces each individual intrigue to connect immediately to politics. (Deleuze and Guattari, 1986 [1975]: 17)

The major literatures and sciences are homogenizing – they bring everything together into a synthetic whole. One need only think of Bruno Latour's (1988 [1984]) characterization of Louis Pasteur to understand how this operation occurs. Slowly but surely, through scientific spectacle and politicking, Pasteur was able to render a new reality, one in which pasteurization was a necessary process to maintain everyday life in France. But minor sciences are more discrete than Pasteur. Their focus on how singularities come into being means they are always attempting to explain something smaller – although that smaller object in the present may unfold with profound implications in the future. It is this possible future that produces the 'cramped space' of the present: the singularities of minor science can eventually lead to the destabilization of other understandings of the

milieus that underpin everyday life and reality. And because of this potential threat they are relegated to a nomadic position, outside of the state. This is emblematized in the figure of the 'bachelor' that Deleuze and Guattari employ to understand Kafka's role in his status as an author of minor literature.

Kafka, like his characters, was prone to bachelorhood. What is the bachelor other than an individual alone, a man or woman against society, a man or woman in waiting? Drawing on the proto-sociological work of Ibn Khladun (1989 [1967]), Deleuze and Guattari posit the bachelor as a mediating term between the nomad and the state: the bachelor is at once outside of the state but positioned to inherit its powers, if her or his fortunes change. It is because of her or his own singularity that she or he can bring the political potential of the minor sciences into being. Deleuze and Guattari characterize this embodiment of the values of minor sciences and literatures in the following way: 'Productive of intensive qualities in the social body, proliferation and precipitation of series, polyvalent and collective connections brought about by the bachelor agent – there is no other definition possible for a minor literature' (Deleuze and Guattari, 1986 [1975]: 71). The bachelor-minor scientist, in her or his search for singularities and their explanation, produces emergent intensities, brings assemblages into presence that previously lay inert. These assemblages are new ways of being, new ways of thinking about the world, and new ways of solving problems; they depend upon assembling disparate bodies of knowledge to produce and solve emergent problems, and thereby create science *qua* science.

Moreover, the bachelor's work serves to create linkages between already-existing, but isolated bodies of knowledge. And this is where the 'revolutionary' power of the minor sciences lies – in bringing new or dormant assemblages into being, thereby challenging the dominant sciences with their own insufficiencies. Deleuze and Guattari write:

> everything takes on a collective value . . . literature finds itself positively charged with the role and function of collective, and even revolutionary, enunciation . . . and if the writer is in the margins or completely outside his or her fragile community, this situation allows the writer all the more the possibility to express another possible community and to forge the means for another consciousness and another sensibility. (Deleuze and Guattari, 1986 [1975]: 17)

This revolutionary power is potentially profound, possibly leading to the replacement of one science with another; and because of this there is a vital interplay of the minor sciences with the dominant sciences they articulate themselves in relation to. Although they may assert themselves in the dominant forms they seek to critique, they cannot become dominant sciences or literatures in their own right – they are marginalized and self-marginalize because their power lies in their critical, external status – unless they metaphysically unsettle dominant sciences to the point of replacing them.

In sum, minor sciences are typified by six qualities: 1) a particular relationship to the capitalist state in which the science and its knowledge are unable to be 'taxed' for

the purposes of the state; that is, minor sciences may be seen as unproductive. 2) Minor sciences depend upon the cultivation of a form of subjectivity in its practitioners that reifies differences of status through the priority of critique, which is related to 3) minor sciences produce revolutionary rather than reproductive knowledge. If dominant sciences are prone to incremental discovery that promotes stability of status, minor sciences attempt to provoke a metaphysical revolution. This is accomplished by 4) the use of language from major sciences that works to recontextualize – and resignify – that language and its relationships to things in the world, which leads to 5) the view of minor sciences as eminently political in their content, leading to their continued marginalization by those in power. For the practitioners of these minor sciences, then, this develops 6) a subjectivity predicated on a bachelor status, a status of waiting for a future in which dominant scientific metaphysics are replaced with those of the minority. We now turn to the case study of contemporary quantum consciousness as a minor science, and how its practitioners act in ways to simultaneously build their science and subtly work to unsettle dominant science.

The case of quantum consciousness

Dr Stuart Hameroff visited the Redwood Center for Theoretical Neuroscience at the University of California, Berkeley in January 2013 to present a talk on 'Quantum cognition and brain microtubules'. About one hundred people of all ages, mostly men, attended the talk. Hameroff is an anesthesiologist and professor emeritus at University of Arizona, Department of Anesthesiology. He is well known in the quantum consciousness world as Director of the Center for Consciousness Studies, also at the University of Arizona. The center hosts the biannual 'Toward a Science of Consciousness' conference. The name of the conference, as Hameroff emphasizes, is meant to suggest that a developed science of consciousness is not here yet, but in the making.

Hameroff's theory was developed in the early 1990s in collaboration with the famous mathematician and physicist Sir Roger Penrose. Quantum consciousness talks like the one given at UC Berkeley attract physicists, neuroscientists, and cognitive psychologists. The sense that consciousness is truly uncharted territory for science makes some scientists open to hearing – if not always endorsing – Hameroff's suggestion that consciousness is the result of quantum computation in the brain's microtubules. Sitting next to Chris Cochran at Hameroff's presentation was a recent vision science PhD who opined that the age of atheism was over and people like Hameroff would necessarily bring metaphysics back into science. Beyond being a vision scientist, this man was a young entrepreneur and seeker of new consciousness-shifting experiences. He anticipated that if Hameroff were correct, a new synthesis would be possible between science and spirituality. In so doing, quantum consciousness science would replace dominant sciences that lack a spiritualist ontology.

In this section, we offer a case study of what we are characterizing as minor sciences, namely contemporary American quantum consciousness. Primarily our

foci are these: What are the claims in this minor science that makes it so radical, so political? How, through language and labor, does this minor science produce and participate in its marginalization? And, finally, how do we see this minor science as informing its dominant counterparts? We begin with a brief overview of quantum physics and quantum consciousness, and then turn to Sir Roger Penrose and Stuart Hameroff, luminaries of contemporary quantum consciousness research. We conclude by isolating the features that make quantum consciousness research a minor science. Throughout, we are interested in how power relations produce quantum consciousness and its practitioners as minoritarian. These acts of power are typically most obvious in institutions and means of knowledge production and dissemination, which are apparent in the marginalized practices of quantum consciousness researchers and their publics.

The social worlds of quantum consciousness

Neils Bohr and his colleagues laid the foundations of quantum mechanics in the 1920s, and gradually individuals explored the implications of quantum physics on epistemology and ontology, which developed into a robust literature in its own right (Bachelard, 1984; Forman, 1971; Jammer, 1974). Speculative work suggested that quantum physics would soon reveal hidden connections between mind and body, spirit and matter – thereby moving beyond secular physics and into the realm of spiritualist metaphysics, which had been jettisoned in the modernization of science. Quantum consciousness' marginal and suspect status in relation to its closest major science, quantum physics, and especially a sub-discipline called quantum foundations, is evident in the boundary-making practices of physicists who label the forms of quantum consciousness research we discuss here as 'pseudoscience' (Stengers, 2009). In so doing, they use their status to marginalize the work of quantum consciousness researchers. Researchers in quantum consciousness maintain a distance from the ordering principles of university research without fully escaping them (Kaiser, 2011), thereby borrowing the power of institutions, but often existing as individuals in tertiary relation to mainstream research foci. Retired or tenured professors sometimes gain greater interest in 'metaphysical' questions because they become less worried about peer approval, publications, and tenure. Other researchers work at 'alternative' universities that were founded during the counter-cultural movements of the 1960–70s, including the California Institute of Integral Studies (CIIS), the John F. Kennedy University (JFKU) of California, and the Marahishi University of Management (MUM) in Iowa, where they position themselves outside of traditional institutional power structures. For example, one lecturer on 'quantum approaches to consciousness' at JFKU whom Cochran interviewed received his master's degree at the same university and makes a living as a real estate agent. He was inspired by Fritjof Capra's *Tao of Physics* (1999 [1975]) at the age of 16 and decided to major in physics as an undergraduate. Other researchers Cochran talked with have a professional career in a discipline outside of physics such as engineering, health care, psychiatry,

or yoga. Relatively few have found a means to study quantum consciousness full time, an index of both the lack of institutional structures to support this kind of research and the marginal status of some of these scientists and the knowledge they produce, which rarely is accepted by scientists in positions of power.

Hybrid conferences bring together scientists, professional mystics, and gurus, and a public that pays between $500 and $2000 for a chance to participate in discussions and workshops with the paid lecturers, including physicists. These annual conferences include the 'Science and Non-duality' conference that takes place in California and Europe, the 'Sages and Science' symposium in Carlsbad, California, and the 'Toward a Science of Consciousness' conference in Tucson, Arizona. Quantum consciousness researchers come to these conferences to promote their findings, discuss science and spirituality with peers, and meet potential philanthropists willing to contribute funds. At these events, advertisement, self-promotion, and research are not clearly separated but entangled categories: at the 'Science and Non-Duality' conference, Cochran encountered spiritual healers discussing their technique with interested medical doctors and physicists discussing interpretations of quantum mechanics with their colleagues. Through a shared minor scientific metaphysics, these researchers are able to discern their sociological differences while collectively in search of an exemplar to upset dominant scientific metaphysics.

Quantum consciousness research also exists in research journals that circulate separately from mainstream physics or psychology journals, a minor literature that helps to reinforce the community of quantum consciousness scientists and their collective practice outside of the power structures of dominant science. This body of journals exists alongside more dominant publications like *Nature* and *Science* as a result of quantum researchers being systematically excluded from publishing their findings in more customary venues due to the unpopularity of their work and claims. Peer-reviewed journals include *Journal of Cosmology* (JOC), *Journal of Scientific Exploration* (JSE), and *Neuroquantology*. JOC publishes articles on interdisciplinary topics in cosmology, astrophysics, biology, geology, and quantum theories of consciousness. JSE publishes on multiple fringe and unexplained phenomena including quantum theories of consciousness, parapsychology, near-death experience, and controversial topics such as non-HIV related theories of AIDS. Articles in *Neuroquantology* present metaphysical speculation and applications of quantum physics to neuroscience and biology. One editor of JSE explained to Cochran that journals such as JSE exist so that scientists with unpopular theories can find a forum where their work will be acknowledged by other scientists. By publishing in venues outside their immediate discipline, minor scientists necessarily reify their outsider status as they sometimes experience difficulty in conveying expert knowledge to scientists outside their own domain of expertise. Finding resonances across theories is necessary among minor scientists because communication is carried out across multiple domains of disciplinary expertise in the search of a common singularity, namely a scientific event or 'new paradigm' that would reconcile differing languages and methods in the study of 'consciousness'. The prestige of physics among the sciences often means quantum consciousness takes a leading role in

this process. For example, in 2011, the *Journal of Cosmology* published a volume guest edited by Sir Roger Penrose and Stuart Hameroff entitled 'Consciousness and the Universe'. The volume includes a new article from Penrose and Hameroff (2011) as well as more than 70 articles considering consciousness from the perspective of research on cosmology, animals, artificial intelligence, human evolution, quantum physics, and psychedelic drugs. Here, and throughout their collective work, quantum consciousness researchers and other minor scientists seek to realign metaphysics with physics, thereby solving the mind-body problem that they see as the inheritance of two thousand years of Western philosophy and replacing it in dominant sciences with a new metaphysical paradigm.

Quantum consciousness as world view

Paul Forman (1980) argues that cultural trends in Weimar Germany, including suspicion of science and a sense of social crisis, profoundly influenced the development of quantum mechanics. As one commentator wrote to Einstein, '[I]t is now the fashion in physical science to attribute something like free will even to the routine processes of inorganic nature' (quoted in Forman, 1980: 293). Today's science of quantum consciousness could be seen as a revival and repetition of the sense of crisis born of social instability and the quantum physics revolution. Many quantum consciousness researchers suggest that quantum physics as a worldview will eventually transform the world in a manner as significant as that of the scientific revolution and Enlightenment of the 17th and 18th centuries. In their view, quantum physics has brought scientific revolution, but our social structure is still based in the older Newtonian worldview. A full paradigm shift will be completed when our human experience is aligned with quantum physical rather than Newtonian principles. The minor science of quantum consciousness finds the possibility of massive social transformation in the image of the paradoxes revealed by quantum physics experiments; it borrows ontological propositions from dominant quantum physics to unsettle assumptions about human experience and epistemology. At a house-party discussion, one quantum consciousness researcher worried about the possibility of nuclear destruction, and suggested that when physics is able to explain consciousness, this knowledge might be absorbed by global culture, leading to greater compassion and hope for the future. Quantum consciousness researchers see the possibility of not only replacing the metaphysical paradigms of dominant sciences but altering the basis of everyday life itself on a global scale, making it a truly revolutionary science.

At the hybrid conferences described above, physicists repeat to their audiences a simple physics experiment called the two-slit experiment. The two-slit experiment is a basic demonstration of quantum physical phenomena. By the end of the conference, attendees know the two-slit experiment as follows. In this experiment an electron source emits electrons through a plate with two slits. A second plate behind the first records the position of electrons as they hit the back plate. In situations where there is no way to record which slit a given electron passes

through, electrons form a diffraction pattern on the back plate. Similar to water waves passing through two openings to produce a diffraction pattern, the arrangement of electrons on the back plate will depend on the distance between the two slits. On the other hand, if the experiment is set up such that which-slit information is physically recorded, then electrons pass through the two slits as if they were tiny balls, forming clumps on the back plate, in line with the position of the two slits. This phenomenon demonstrates what is called wave-particle duality.

As is well known amongst physicists, Richard Feynman once explained that the two-slit experiment 'contains the only mystery. We cannot make the mystery go away by ''explaining'' how it works' (1964: 37). Quantum consciousness researchers repeat the Feynman quote to audiences and to each another. These minor scientists insist on the intractability of the mystery and constantly mull over its implications. The two-slit experiment reveals that particles have complementary wave- and particle-like properties. Niels Bohr used 'complementarity' to refer to the fact that certain physical situations that make possible one kind of measurement exclude the possibility of another kind of measurement.[6] Particles and waves are complementary phenomena: wave-like properties, such as diffraction, are not found in particles. Likewise, particle-like properties, such as determinate position, are not found in waves. An electron can behave as a particle or a wave in different situations: complementarity refers to the fact that an experiment that reveals wave-like attributes restricts measurement of particle-like attributes. Physicists interested in quantum physics and consciousness use the principle of complementarity to speculate on the metaphysical unity between mind and matter, or to elaborate on the difficulties of the mind-body problem; they also see in the two-slit experiment a failure in the construct paradigms of dominant sciences that might be exploited to provoke a paradigm shift towards quantum consciousness.

A related implication of quantum physics that gives rise to quantum consciousness research is the so-called measurement problem. Any quantum mechanical experiment includes a physical measurement that resolves indeterminacy within the system and gives a recordable measurement. The state of a particle prior to its observation in an experiment can be described as a superposition of mutually incompatible possible states. A popular explanation involves the plight of Schrodinger's cat, who is proposed to be in a superposition of live and dead states prior to measurement, at which point the experimenter will find either a living or dead cat. A superposition of states of a particle can be described mathematically in an abstract vector space. After experimental observation, the particle transitions probabilistically to a single observed outcome; a superposition is never observed. The measurement problem considers the nature and meaning of the transition, which is sometimes called the collapse of the wave function. Most physicists think the transition is adequately explained by decoherence theory – the loss of information from a system into the environment. However, some argue that decoherence explains the transition only for all practical purposes, but does not account for the apparent ontological disjuncture between the atomic world and human experience. Such physicists adhere to a view put forward by mathematician John

von Nuemann in 1932 and repeated by physicist Eugene Wigner in 1961. This view states that consciousness must account for the real collapse of the wave function because everything in the physical system must be described in superposition. In this view, consciousness, being non-physical, must cause the transition from superposition of states – which cannot be experienced – to a single state, which is always the observed result.

While there are other important implications of quantum physics that fuel quantum consciousness research, we limit our present discussion to the phenomena of complementarity and the collapse of the wave function by consciousness through measurement. In these two principles, we can see the heterodoxy of quantum physics' minor science, quantum consciousness. In the case of complementarity, a metaphysical principle is found to unite consciousness and matter, while in the case of the collapse of the wave function a dualistic division of mind and matter leads to the conclusion that mind has an as-yet-unexplained influence on matter. Placing these two seemingly contradictory concepts in dialogue leads not to futility but rather to a heterogeneous array of hypotheses on the relationship between consciousness and quantum physics, which lays the basis for the minor science of quantum consciousness, and might also lead to the possible revolution of quantum physics – and all dominant sciences that depend upon the occlusion of these problems as necessary to their continued status as dominant.

Interpreting consciousness

Disagreement over what quantum physical formalism tells scientists about nature has produced the field of quantum physics interpretation, including 'Copenhagen', 'many worlds', and 'hidden variables' theories (Cushing, 1994; Teller, 1997; Albert, 1992; Zurek and Wheeler, 1983). Questions that give rise to quantum physics interpretations also fuel research in quantum consciousness connections. The textual life of quantum physics interpretation stands within mainstream physics journals and publishers, the blogosphere, and books written by prominent physicists for the public. Physicists and philosophers specialize in the topic professionally as professors in academic research institutions. Quantum consciousness research overlaps somewhat with quantum physics interpretation, but it is not the same and its status within that discipline is questionable, according to most physicists (Schlosshauer, 2007; Stengers, 2009). A few physicists have managed to bridge the gap, including Henry Stapp and Sir Roger Penrose. During interviews, physicists commonly report that Stapp and Penrose are widely respected because they have made important contributions to physics before publishing work on quantum consciousness, thereby demonstrating their value both as dominant and minor scientists based upon institutionalized power structures.

Perhaps the most famous interpretation of quantum physics that includes discussions of consciousness is by Penrose, a prominent mathematician and physicist who is well known for his contributions to cosmology and general relativity. To explore the relationship between minor sciences and dominant science, we will

elaborate on Penrose's status as both renowned mathematician of the dominant sciences and hero of the minor science. This status is due to his recognition as powerful in dominant sciences – and influential in quantum consciousness circles. When Cochran interviews physicists about Penrose, most respond that he is a very accomplished scholar but does not understand quantum physics interpretation. As one physicist told Cochran, 'That is where Penrose goes nutty.' Most neuroscientists interviewed by Cochran also disagree with Penrose's ideas on physics and consciousness, including his claim that consciousness cannot be explained by currently known scientific laws. However, scientists and philosophers find his work worthy of serious consideration, if only for the purpose of refutation (Grush and Churchland, 1995; Penrose et al., 1997; Tegmark, 2000). Penrose's interlocutors often argue that the claim that consciousness is non-computational is unwarranted given what they see as the success of computational models that posit consciousness as an emergent property of neural networks. Furthermore, the Penrose-Hameroff theory is seen by some as a conjecture rather than a hypothesis; for example, Patricia Churchland famously commented, 'Quantum coherence in the microtubules is about as explanatorily powerful as pixie dust in the synapses' (Churchland, 1998: 121). Despite these objections, minor scientists in quantum consciousness deeply value Penrose and his work, in no small part due to his institutionalized status within physics.

Penrose argues that physics is incomplete because there is no adequate physical explanation of wave function collapse, and he rejects decoherence theory as a satisfactory explanation. This position makes Penrose a powerful authority and ally of less recognized quantum consciousness researchers that want to make room for their own interpretations of quantum physics as yet another alternative to the hegemonic one, as they borrow from his power and status. Penrose believes that the collapse of the wave function has an objective physical reality that will eventually be explained by a new physical theory (Penrose et al., 1997: 63), thereby supplanting existing dominant scientific paradigms at the metaphysical level. He also argues that modern physics is insufficient to describe the phenomenon of consciousness, making physics incomplete. According to Penrose, neither the currently popular computational models of consciousness nor modern quantum physics can fully explain phenomena such as awareness, understanding, and the feeling of free will (Penrose et al., 1997: 113). However, Penrose hopes that these gaps in physics and cognitive science are somehow linked. He suggests a future revolutionary theory of quantum gravity might explain both the collapse of the wave function and consciousness in physical terms (Penrose et al., 1997: 133–4). With the help of Stuart Hameroff, Penrose has even suggested a possible biological mechanism for how the brain might work like a quantum computer, the basis of Churchland's dismissal presented above.[7]

Penrose's theory identifies lacunae including the measurement problem in quantum physics and the difficulty of producing a scientific explanation for consciousness, and searches for ways to bridge them, thereby producing them as an assemblage in need of solution. In doing so, he ignores boundary-making practices

that constitute the division of labor in disciplinary science. While he does not deny the importance of expertise, he does not yield to it either. He takes authority upon himself to assess and bridge concepts from physics, biology, and cognitive science. As a result, Penrose and Hameroff have stood as minor scientists: advocates of a well-known, speculative theory that is nevertheless rarely utilized by other scientists. Perhaps this is why a few quantum consciousness researchers have told Cochran that Hameroff sometimes behaves more like a pitchman than a theorist. The unrecoverable nature of the Penrose-Hameroff theory can be understood in terms of its deterritorialized metaphysical valences. In their responses to Penrose, Grush and Churchland (Grush and Churchland, 1995) and Cartwright and Hawking (Penrose et al., 1997) all suggest that Penrose's metaphysical commitments have a status outside of science. In each case, explicit metaphysical considerations are considered a hindrance to science.

To take one example, Stephen Hawking does not feel the need to explain why positivism is preferable to Platonism; rather, merely bringing attention to Penrose's Platonist commitment is enough – in Hawking's eyes – to explain his disinterest in a deep engagement with Penrose's theory (Penrose et al., 1997: 169). Importantly, Penrose does not reply by objecting to Hawking's philosophical commitment to positivism. Instead, he denies that their differences are metaphysical, but have more to do with the adequacy of current theory to explain available data (Penrose et al., 1997: 183). In each case metaphysics is rendered 'political' and not 'scientific' in that it is figured either as a danger to science or a contingent position that must be compared to the available evidence. In the deterritorializing discourse of minor science, new metaphysical positions are posited as necessary changes to account for empirical deficiencies in current scientific theory. This is both the strength and weakness of minor science: while it enables rupture within the dominant paradigm, it also leads to the possibility of dismissal through further empirical argument. For example, Tegmark (2000) has tried to show that decoherence occurs too fast in the brain for quantum phenomena to occur. If correct, Tegmark's response to Penrose shows that the paradigm change Penrose advocates is unlikely because it does not fit with the empirical data. In each case, the attacks on Penrose seek to render him powerless by delegitimizing his status or claims – his detractors seek to make him less of a scientist by dominant standards.

The implications of interpretation

While Penrose's theory is generally criticized in the major fields of physics, biology and neuroscience, it has been applauded and often cited among quantum consciousness researchers. Because of Penrose's notoriety, lesser-known theorists often compare and contrast their own theory to the Penrose-Hameroff model. At the 'Science and Non-Duality' (SAND) conference in 2010, Hameroff recounted the Penrose-Hameroff theory in his keynote speech to about 500 conference participants. Throughout the rest of the conference, aspiring theorists referenced the

Penrose-Hameroff theory as an authoritative account, but did not build on the theory or challenge it. Instead, new and usually less detailed theories were put forward alongside the Penrose-Hameroff theory. Allegiance was based on a mutual desire to overthrow the current paradigm as much as a desire to build a new paradigm. SAND participants spoke about and heard the Penrose-Hameroff model as part of a wider attempt to reject the materialist paradigm and to forge a new paradigm that combines scientific and spiritual knowledge.

Quantum consciousness is able to exist as a minor science by drawing on the authority and resources of university physics while at the same time positioning itself as a contributor to American spiritual and metaphysical cultures. Many quantum theorists of consciousness depend on wealthy donors interested in questions about science, religion, metaphysics and their overlaps (Kaiser, 2011). One researcher, who prefers anonymity because of career concerns, was invited to an institute in Sweden that she called 'very secretive'. The institute had heard about her experimental quantum consciousness research and wanted her to interview for a possible grant. Businessman Klee Irwin, on the other hand, is open about his enthusiasm in funding physicists to develop a new paradigm of consciousness-inclusive physics. He currently employs a physicist and mathematician full time at his home. In an interview with Cochran, he explained the difference between his research and university research:

> You can actually sample the work of some physicists out there; and they have some interesting robust mathematics, they seem to be pretty adept at their subject but they approach it in a non-cookie cutter way, and not militantly obedient to the process of the way the information is presented at the steps of academia proper [. . .] I'm not doing this to get a Nobel Prize, or to get a post at some really awesome university or something. You know I'm not in academia. My motivation is not professional recognition or fame, and it is also not commercial. And I don't have an interest in the money that could come from it. Because I made, I have a lot of money. I made my money as an entrepreneur doing other things.

For Irwin, access to wealth produces a means to escape the demands of academic discipline, including publication in recognized journals, and following recognized methods. Whereas for dominant scientists, support by the state is vital to their continued financial well-being, for the independently wealthy it is possible to support minor science through alternative monetary sources which exempt them from dominant power structures and allow them to establish themselves through alternative means.

Some physicists have gained a significant following by writing popular books and public lecturing on the topic of quantum physics and consciousness, including Fred Alan Wolf, Amit Goswami, and John Hagelin; this work explicitly seeks a popular audience in an attempt to create external pressure in society to force scientific consideration of quantum consciousness science. In so doing, these actors see the one possible way to trump institutionalized power structures is through

appeals to a public that might come to make demands of public universities and research centers. Popular writing on quantum theories of consciousness often use a reinterpretation of Kuhn's notion of paradigms to suggest that the emergence of the science of quantum physics will eventually transform global culture (Nadeau and Kafatos, 2001; Radin, 2006; Zohar, 1991). Authors and readers understand their own spiritual, metaphysical and neo-pagan movements – fueled by self-help, popular psychology and alternative medicine industries – to be proof of this emergent transformation. An undergraduate taking a course about quantum physics for non-science majors at UC Santa Cruz explained to Cochran how he and his friends developed their interest in quantum physics by watching *The Quantum Activist*, a film about physicist Amit Goswami, professor emeritus at the University of Oregon. In the film, Goswami explains the consciousness-induced collapse of the wave function explicated by Von Neumann and Wigner and argues that quantum physics can give us a deeper understanding of our true conscious nature. Goswami posits himself as an arbiter of the social change that is brought on by the paradigm shift started by the advent of quantum physics, which, according to him, 'overturned' the 'materialist paradigm' (Goswami, 1995).

For most physicists, the ethical implications of science derive from norms about scientific method. When asked, physicists sometimes comment on the democratic and rational elements of science that serve as a model for civic life (Primack and Abrams, 2007; Smolin, 2006). However, on an ontological level, quantum physics is said to have little or no scientific consequences for issues such as human experience and ethics, processes that occur at the higher physical scale of individual bodies and society, and which are better explained by the disciplines of biology and psychology. However, quantum consciousness research forges a short circuit – a direct connection – between the atomic scale and human experience. In doing so it not only challenges current paradigms but also current divisions of labor that define and regulate expert knowledge within science. Quantum consciousness research makes quantum physics more accessible to the public – in saying that humans directly experience a quantum physical phenomenon, namely consciousness – and in the same movement enlists thinkers of all kinds to challenge the mainstream scientific paradigm, thereby rendering itself an intensely political science.

In calling for a new paradigm, quantum consciousness rehearses the necessity of starting over with a new ontology. It is concerned less about developing the standard model of modern particle physics than it is in developing the philosophical implications of quantum physics' basic attributes including superposition, wave function collapse, and non-locality. It takes the same approach to consciousness, insisting that metaphysical considerations are necessary to resolve the 'hard problem' of how qualitative experience emerges from physical reality (Chalmers, 1995). Furthermore, the contingency of knowledge is recognized by quantum consciousness researchers on account of the difficulty of stabilizing an ontological field from which to understand the relation between mind and matter. But, given their institutionally marginalized status – as evident in their conferences, their publication venues, and even the status of the most lauded contributors to

quantum consciousness research – it is unclear if the message of quantum consciousness will be received by dominant sciences or the public more generally.

Conclusion

As scientific disciplines continue toward specialization, some scientists see the opportunity to capitalize upon lacunae in thought to forward new scientific paradigms. This is clearly the case of quantum consciousness researchers, who, across the many fields they come from and find inspiration in, labor at one critical nexus – that of consciousness and the material world – to unsettle dominant scientific paradigms. Instead of operating solely in the idiom of a lone, dominant science, these researchers draw on transdisciplinary possibilities to carve out new terrain for thought and scientific action. These minor scientists deterritorialize dominant science, as those in positions of power work to condemn, ignore, or disprove their work; they also stand alone, disenfranchised from institutional structures that support dominant science. But, in standing alone, they anticipate a day when they will be proven correct, and their paradigm will replace dominant scientific metaphysics. Attention to minor sciences like quantum consciousness studies helps to move historians and ethnographers of dominant science away from Whiggish accounts of science: dominant sciences are not inevitable nor the only sciences operating at any given moment in time. Seeking out minor sciences and their minoritarian discourses helps to expose the sometimes-sensitive, metaphysical underbellies of those in power. It also helps to expose what power structures underlie the preservation of dominant sciences and institutions. Minor sciences can be discrete at times, laboring in obscurity; or, like quantum consciousness researchers, they can announce themselves as a new paradigm. In either case, they demand our attention.

In this article, we have provided a framework for this anthropological attention to minor sciences, stressing the power relations between dominant and minor sciences as a means to account for how scientific paradigms shift as a result of external pressure. This is not to argue that scientific change is dialectical in that there is an inevitable synthesis between a dominant and minor science, but rather that the replacement of dominant paradigms results in the transposition of those in and out of power; dominant sciences can become minor as minor sciences ascend to positions of power. This shift is recognizable in the dominant status of psychoanalysis in the early 20th century, which was steadily replaced by laboratory-based neuroscience to the point of placing psychoanalysis in the position of the minority science (Wolf-Meyer, 2015). In the case of quantum consciousness, we see the continued existence of a minor science as minor, lacking the institutional support of the state, a language wholly its own, and a position of power. Instead – and these are the features that define its minority and deserve the attention of anthropologists in other contexts of expertise at work – it borrows a dominant language, thereby deterritorializing the dominant sciences it relates to, it exists in a politicized state as evidenced in its status as discredited, and depends upon a future-oriented temporality, awaiting its ascendency to a position of dominance. Attending to these features focuses

ethnographic attention on a set of qualities in practice and thought that displaces understandings of paradigm shifts as happening from within and, instead, forces attention to the power relations between scientists and those they would discredit as 'weirdos' or 'New Agers'. Doing so situates science squarely in the context of society more generally (Martin, 1997), moving away from strictly positivist accounts of paradigm shifts and recognizing that paradigms might shift as a result not of new scientific discoveries but in changes in what counts as science at all.

Anthropologists have long been attracted to what we might now characterize as minor sciences – from the invention of artificial life (Helmreich, 1998) to anti-aging therapeutics (Mykytyn, 2006), from cryonics (Romain, 2010) to space travel (Valentine, 2012). This interest may be a result of the romanticization of resistance (Kliger, 1996): that minor sciences offer anthropologists cases of scientists resisting dominant paradigms. It may also be due to the recurrent anthropological interest in the emergent, those practices that are at once novel yet increasingly normative (Wolf-Meyer, 2013). And it may also have to do with the internalization of anthropology's own minor status, particularly in relation to its sibling disciplines in the social sciences, including sociology, economics, psychology, and political science, all of which have become enshrined in the operations of neoliberal governments in the North Atlantic, whereas anthropology has largely remained outside of the machinery of government. Any one of these explanations is surely incomplete: for every anthropological study of a minor science, there are many more that focus on dominant sciences; for every study of an anticipatory science, there is an equal number of sciences which have failed; and, for however much anthropology can sometimes seem marginalized within contemporary neoliberal paradigms of governance, it is also the basis of the world as it has been ordered over the last two centuries (Trouillot, 2003). That anthropologists continue to be drawn to the study of minoritarian sciences and narratives about their own science raises questions about what anthropologists perceive in the potentials of minoritarian practices and whether we anticipate inheriting a future wherein anthropology has a place at the table of governance, or if we have already inherited that future and are now looking for a way towards a less troubling alternative.

Notes

1. We use 'we' throughout this article for the purpose of readability; however, Cochran conducted the fieldwork that this article is based on. His fieldwork is comprised of interviews with quantum consciousness researchers and other physicists, chemists, and neuroscientists who offer contrasting opinions about consciousness and its relation to theoretical physics. His fieldwork also includes participation in conferences, classrooms, publication processes, and spiritual activities where quantum consciousness is a focus. Cochran's dissertation shows how and why quantum consciousness scientists navigate the antinomies of the quantum measurement problem and the mind-body problem in search of a 'spirituality' derived from scientific concepts. Quantum consciousness scientists break disciplinary boundaries in science because they are motivated by their anxieties about the future, including fears about climate change, economic collapse, or nuclear holocaust. Cochran argues this heightened

anxiety makes antinomies in scientific concepts – especially the quantum measurement problem and the mind-body problem – appear as compelling signs that lure quantum consciousness scientists' consciousness toward a 'spiritual' transformation of science that can save the planet, as a result giving revivalist and millennial tones to narratives of scientific progress typically understood as secular or secularizing. The framework of minor sciences and literatures is based on Wolf-Meyer's research on alternative neuroscientific movements in the 20th century, which focuses on movements in American neuroscience and cognate fields as they struggle with changing ideas about neurological disability.

2. Deleuze and Guattari use these three terms – 'dominant', 'major', and 'royal' – interchangeably. For our purposes, we adhere to their usage of dominant throughout this paper. Moreover, they use 'nomad' and 'minor' science interchangeably as well, depending on the context in which they are writing.
3. Deleuze and Guattari write: 'Reproducing implies the permanence of a fixed point of *view* that is external to what is reproduced . . . following is something different from the ideal of reproduction. Not better, just different. One is obliged to follow when one is in search of the ''singularities'' of a matter, or rather of a material, and not out to discover a form' (1987 [1980]: 372).
4. For example, the *Journal of Scientific Exploration*, discussed below, states as its mission to provide a forum for the scientific study of unexplained phenomena which do not traditionally fall within the purview of scientific study.
5. 'A minor literature doesn't come from minor language; it is rather that which a minority constructs within a major language. . . . The first characteristic of minor literature is in any case that in it language is affected with a high coefficient of deterritorialization' (Deleuze and Guattari, 1986 [1975]):16).
6. William James used the term complementarity to describe the nature of the mind before Bohr's use. While scholars debate the influence of James on the thought of Bohr, it is enough for our purposes that the notion quickly gained traction, travelling across disciplines including psychology, linguistics, ethics and theology (Jammer, 1974: 88).
7. Penrose and Hameroff argue that microtubules, which are structures within the neuron, might be capable of maintaining quantum coherence long enough for the brain to exhibit quantum phenomena at a global level (Penrose and Hameroff, 2011).

References

Albert D (1992) *Quantum Mechanics and Experience*. Cambridge, MA: Harvard University Press.

Bachelard G (1984) *The New Scientific Spirit*. Boston: Beacon Press.

Capra F (1999 [1975]) *The Tao of Physics: An Exploration of the Parallels between Modern Physics and Eastern Mysticism*. Boston: Shambhala.

Chalmers D (1995) Facing up to the problem of consciousness. *Journal of Consciousness Studies* 2: 200–219.

Churchland P (1998) Brainshy: Nonneural theories of conscious experience. In: Hameroff SR, Kaszniak AW and Scott AC (eds) *Toward a Science of Consciousness: The Second Tucson Discussions and Debates*. Cambridge, MA: MIT Press, pp. 109–124.

Cushing JT (1994) *Quantum Mechanics: Historical Contingency and the Copenhagen Hegemony*. Chicago: University of Chicago Press.

Deleuze G and Guattari F (1983 [1972]) *Anti-Oedipus*. Minneapolis: University of Minnesota Press.

Deleuze G and Guattari F (1986 [1975]) *Kafka: Toward a Minor Literature*. Minneapolis: University of Minnesota Press.
Deleuze G and Guattari F (1987 [1980]) *A Thousand Plateaus*. Minneapolis: University of Minnesota Press.
Deleuze G and Guattari F (1996 [1991]) *What Is Philosophy?* New York: Columbia University Press.
Eckberg DL and Hill L (1979) The paradigm concept and sociology: A critical review. *American Sociological Review* 44: 925–937.
Feynman RP (1964) *The Feynman Lectures on Physics: The Definitive and Extended Edition*. Boston: Addison-Wesley.
Forman P (1971) Weimar culture, causality, and quantum theory: Adaptation by German physicists and mathematicians to a hostile environment. *Historical Studies in the Physical Sciences* 1: 1–115.
Forman P (1980) Weimar culture, causality, and quantum theory: Adaptation by German physicists and mathematicians to a hostile environment. In: Chant C and Fauvel J (eds) *Darwin to Einstein, Historical Studies on Science and Belief*, Harlow: Longman, pp. 267–302.
Goswami A (1995) *The Self-Aware Universe: How Consciousness Creates the Material World*. New York: Tarcher.
Grush R and Churchland P (1995) Gaps in Penrose's toilings. *Journal of Consciousness Studies* 2: 10–29.
Haraway D (1997) *Modest_Witness@Second_Millennium.FemaleMan©_Meets_Onco Mouse*^{TM}. New York: Routledge.
Helmreich S (1998) *Silicon Second Nature: Culturing Artificial Life in a Digital World*. Berkeley: University of California Press.
Helmreich S (2009) *Alien Ocean: Anthropological Voyages in Microbial Seas*. Berkeley: University of California Press.
Hess DJ (1993) *Science in the New Age: The Paranormal, Its Defenders and Debunkers, and American Culture*. Madison: University of Wisconsin Press.
Jammer M (1974) *The Philosophy of Quantum Mechanics: The Interpretations of Quantum Mechanics in Historical Perspective*. Hoboken: Wiley.
Kaiser D (2011) *How the Hippies Saved Physics: Science, Counter-culture and the Quantum Revival*. New York: W. W. Norton.
Khladun I (1989 [1967]) *The Muqaddimah: An Introduction to History*. Princeton: Princeton University Press.
Kliger R (1996) 'Resisting resistance': Historicizing contemporary models of agency. In: Nader L (ed.) *Essays on Controlling Processes*. Berkeley: Kroeber Anthropological Society, pp. 137–156.
Knorr-Cetina K (1999) *Epistemic Cultures: How the Sciences Make Knowledge*. Cambridge, MA: Harvard University Press.
Kuhn TS (1970 [1962]) *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.
Kuttner F and Rosenblum B (2011 [2006]) *Quantum Enigma: Physics Encounters Consciousness*. New York: Oxford University Press.
Latour B (1988 [1984]) *The Pasteurization of France*. Cambridge, MA: Harvard University Press.
Latour B (1999) *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA: Harvard University Press.

Latour B (2005) *Reassembling the Social: An Introduction to Actor-Network Theory*. New York: Oxford University Press.
Latour B and Woolgar S (1986 [1979]) *Laboratory Life: The Construction of Scientific Facts*. Princeton: Princeton University Press.
Lee S, Koenig B and Richardson S (2008) *Revisiting Race in a Genomic Age*. New Brunswick: Rutgers University Press.
Lynch M (1985) *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory*. Boston: Routledge.
Marks J (2009) *Why I Am Not a Scientist: Anthropology and Modern Knowledge*. Berkeley: University of California Press.
Martin E (1991) The egg and the sperm: How science has created a romance based on traditional gender stereotypes. *Signs* 16: 485–501.
Martin E (1994) *Flexible Bodies: Tracking Immunity in American Culture – From the Days of Polio to the Age of AIDS*. Boston: Beacon Press.
Martin E (1997) Anthropology and the cultural study of science: From citadels to string figures. In: Gupta A and Ferguson J (eds) *Anthropological Locations: Boundaries and Grounds of a Field Science*. Berkeley: University of California Press, pp. 131–146.
Masco J (2006) *The Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico*. Princeton: Princeton University Press.
Masterman M (1970) The nature of a paradigm. In: Lakatos I and Musgrave A (eds) *Criticism and the Growth of Knowledge*. Cambridge: Cambridge University Press, pp. 59–90.
Montoya MJ (2011) *Making the Mexican Diabetic: Race, Science, and the Genetics of Inequality*. Berkeley: University of California Press.
Mykytyn CE (2006) Anti-aging medicine: Predictions, moral obligations, and biomedical intervention. *Anthropological Quarterly* 79: 5–31.
Nadeau R and Kafatos M (2001) *The Non-Local Universe: The New Physics and Matters of the Mind*. Oxford: Oxford University Press.
Penrose R and Hameroff S (2011) Consciousness in the universe: Neuroscience, quantum space-time geometry and Orch OR theory. *Journal of Cosmology* 14. Available at: http://journalofcosmology.com/Consciousness160.html (accessed 20 October 2015).
Penrose R, Cartwright N, Hawking S, et al. (1997) *The Large, the Small and the Human Mind*. Cambridge: Cambridge University Press.
Primack J and Abrams N (2007) *The View From the Center of the Universe: Discovering Our Extraordinary Place in the Cosmos*. New York: Riverhead.
Rabinbach A (1990) *The Human Motor: Energy, Fatigue, and the Origins of Modernity*. Berkeley: University of California Press.
Radin DI (2006) *Entangled Minds: Extrasensory Experiences in a Quantum Reality*. New York: Paraview Pocket Books.
Roediger D and Foner P (1989) *Our Own Time: A History of American Labor and the Working Day*. New York: Verso.
Romain T (2010) Extreme life extension: Investing in cryonics for the long, long term. *Medical Anthropology* 29: 194–215.
Schlosshauer M (2007) *Decoherence and Quantum to Classical Transition*. Berlin: Springer.
Smolin L (2006) *The Trouble with Physics: The Rise of String Theory, the Fall of a Science, and What Comes Next*. Boston: Houghton Mifflin.
Stengers V (2009) *Quantum Gods: Creation, Chaos and the Search for Cosmic Consciousness*. Amherst: Prometheus Books.

Taussig K-S (2009) *Ordinary Genomes: Normalizing the Future through Genetic Research and Practice*. Durham: Duke University Press.
Taussig K-S, Rapp R and Heath D (2003) Flexible eugenics: Technologies of the self in the age of genetics. In: Goodman A, Heath D and Lindee S (eds) *Genetic Nature/Culture: Anthropology and Culture Beyond the Two Culture Divide*. Berkeley: University of California Press, pp. 58–76.
Taylor FW (1998 [1911]) *The Principles of Scientific Management*. Mineola: Dover Publications.
Tegmark M (2000) The importance of quantum decoherence. *Brain Processes Physical Review E* 1: 4194–4206.
Teller P (1997) *An Interpretive Introduction to Quantum Field Theory*. Princeton: Princeton University Press.
Thompson EP (1980 [1963]) *The Making of the English Working Class*. New York: Penguin.
Traweek S (1988) *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge, MA: Harvard University Press.
Trouillot M-R (2003) *Global Transformations: Anthropology and the Modern World*. New York: Palgrave Macmillan.
Valentine D (2012) Exit strategy: Profit, cosmology, and the future of humans in space. *Anthropological Quarterly* 85: 1045–1068.
Wolf-Meyer M (2013) Where have all our naps gone? Or Nathaniel Kleitman, the consolidation of sleep, and the historiography of emergence. *Anthropology of Consciousness* 24(2): 96–116.
Wolf-Meyer M (2015) Our master's voice, the practice of melancholy, and minor sciences. *Cultural Anthropology* 30(4): 670–691.
Zohar D (1991) *The Quantum Self: Human Nature and Consciousness Defined by the New Physics*. New York: Harper Collins.
Zurek W and Wheeler J (1983) *Quantum Theory and Measurement*. Princeton: Princeton University Press.

Matthew Wolf-Meyer is an Associate Professor of Anthropology at Binghamton University. His work focuses on medicine, science and media in the United States to make sense of major modern-era shifts in the expert practices of science and medicine and popular representations of health. His latest book is The Slumbering Masses (UMN Press 2012).

Chris Cochran is currently a Ph.D. candidate at University of California Santa Cruz and Lecturer at Mills College. His dissertation fieldwork on quantum consciousness was supported by the National Science Foundation Doctoral Dissertation Improvement Grant. He is currently completing his dissertation and working as Staff Researcher in the Vision Science Department at University of California, Berkeley, a position that coincides with a new ethnographic project on quantum physics foundations.