

A STRUCTURAL THEORY OF EVERYTHING

Brian D. Josephson

ABSTRACT: Karen Barad's Agential Realism provides a non-paradoxical realist account of quantum reality, but does not show how the complex picture that it implies can be applied to the familiar physics of the laboratory. Here, motivated by parallels with the way human cultures evolve, the theory is augmented by the inclusion of evolutionary processes. The outcome is the understanding that organised activity at deeper levels can result in the emergence of entities such as universes, and phenomena in these universes, including possibly life and the evolution of life. It is argued that agential realism is not essentially new to science, differing from the kinds of ordered structures familiar in physics mainly through the role played by the semiotic, or interpretive information-processing, aspects of the theory.

Keywords: Karen Barad; Agential Realism; Emergence; Semiotics; Interpretive Information Processing

INTRODUCTION

This paper discusses a proposal that might be called 'a structural theory of everything', very different in character to conventional theories based upon quantum mechanics. It is an extension of Barad's 'agential realism' (1), which attempted to demystify quantum mechanics, and which might be characterised as a description of the 'machinery of nature'. This approach is consistent with Kastner's 'possibilist' interpretation of quantum mechanics (2). The extension of agential realism discussed here involves taking account of the evolutionary potential of the 'discursive practices' that play an essential role in Barad's picture, which potential is akin to the potential that ordinary discourse has in regard to representing and making use of discoveries. In an equivalent way, evolving representations created at deeper levels of reality provide mechanisms

for the emergence of the ordinary laws of physics, and also, in part, specific phenomena governed by these laws, thereby providing a basis for Wheeler's conjecture that 'observer-participation' can be 'the foundation of everything' (3). The phenomena to which such mechanisms are relevant include the origin of life and, more controversially, the possibility that aspects of the evolution of species may be influenced from a deeper level.

STATISTICAL VS. REALIST MODELS OF THE QUANTUM DOMAIN

As noted in (4), physicists dealt with the unpredictability that seems to be an inherent feature of the quantum realm by espousing theories capable of predicting averages with a high degree of accuracy, but this may lead to the neglect of significant characteristics of individual instances of a phenomenon. Quantum mechanics has chosen to be blind as regards what may be happening in individual cases, concern being much more with the production of all-inclusive models. While this strategy has undeniably been the source of remarkable successes, it is also proving problematic at the present time, in part as it has led to a situation where there is limited contact between theory and experiment, something that is an essential requirement for producing theories with wide-ranging predictive power.

Realist models, by way of contrast to the above, do focus on individual instances. An early realist model was Bohm's hidden variable picture, depending for its success on the introduction of a non-local quantum potential with unusual characteristics. It was motivated chiefly by the wish to reproduce accurately the predictions of quantum theory. The theories invoked in the current paper have a different motivation, namely the wish to produce a picture that makes intuitive sense, the hope being that some future development of the ideas may in addition disclose how the quantitative aspects of nature arise. The present paper takes steps towards fulfilling that goal.

INDETERMINACY

Barad's agential realism, an attempt to make sense of the quantum domain in realist terms, is a development of ideas due to Niels Bohr. Bohr argued that details of the quantum domain are in general not merely *uncertain*, a reference to mere ignorance of the details, but *indefinite* or *indeterminate*, in the sense that

treating values of variables as definite can lead to contradictions. For example, when a beam of light is split into two by a beam splitter and combined in such a way as to give rise to an observable interference pattern, we may be inclined to ask which path was taken by an individual detected photon. But determining which path a given photon takes, using a suitably placed photon detector, would prevent interference, implying that the question of which path a particular photon took has no clear answer.

This leads to a curious ambivalence as to what ‘really happens’. The fact that photons can be detected would suggest that it makes sense to ask where a given photon is, but that would seem to preclude the possibility of the photon acting like a wave, as seems to be dictated by the fact that interference indicative of waves can be demonstrated. Clearly, the quantum domain cannot be pictured in the same way that classical reality can.

Bohr addressed this conundrum by arguing that despite reality in the quantum domain being indeterminate, that indeterminacy is only partial. We can in certain circumstances say that an electron is a particle, and in others that it is a wave, though never that it is both. The context determines what can definitely be said, and the fact that a measurement has taken place, whatever the outcome, is one circumstance where something definite can be said.

Barad generalises this analysis by invoking *agencies* that are the source of observable *phenomena*. Note that while observable phenomena have a concrete reality, the same cannot necessarily be said of agencies, which term is in general an abstraction, with a utility in speaking of nature. The possible abstract character of agencies is illustrated by the example of vibrations in classical physics: we may legitimately say that a vibration was the cause of some particular damage, but the question of what was vibrating has no precise answer, since in general no sharp boundary can be drawn between what is vibrating and what is not. This indefiniteness does not however detract from the utility of speaking of agencies and, where possible, modelling their behaviour.

The fact that measuring instruments, or more generally agencies whatever they may be, are able to make definite what was previously indefinite, means that they are a special kind of system, and the question arises as to why particular systems should possess this characteristic. This introduces a new concept, that of *discursive practice*. Measuring instruments can initially produce

unreliable readings and are in need of refinement, which refinement is governed by some notion of what is the quantity being measured. In general, design makes use of an understanding of the dependence of the performance on a range of factors, which understanding can typically be expressed in verbal form. One may infer that processes of the character of discourse are crucial for accurate measurement to be possible.

Barad proposes that measurement in the laboratory, resulting in it being possible to make definite assertions regarding a quantum object, has to be viewed merely as a special case of a more general phenomenon associated with causing some aspects of nature to become definite. This generalisation consists in the assertion that *agencies* are present in nature that typically act in cooperation with each other, producing specific phenomena describable as the *performance* associated with such collections of agencies, which performance is in large part consequent upon *organisational information exchange having the character of discourse*, a point to which we shall return.

ENTANGLEMENT AND MEANING

At this point entanglement of a generalised kind enters the picture. Any process that causes something to become definite can be viewed as a unit, where a number of agential processes work together to produce some specific result. This unit involves a number of agencies, interacting with each other in very specific ways determined by the fact that their coordinated activities produce the outcome associated with the unit. Barad gives such interactions the name *intra-actions*, to symbolise the fact that they happen within some unit, and have a special ability to cooperate. Systems are described as entangled when they are in such a cooperating situation.

The concept of meaning arises naturally in this picture, since cooperation is enhanced by anticipation, through which actions can take account of what is likely to happen. Anticipation, as discussed in the semiotic theories of Peirce (5), involves a process of interpreting signs in a context dependent way.

Peirce's account of meaning, consistent with that of Barad, differs from the version that assigns a specific meaning to a given sign, in that a sign may usefully refer to something different in different contexts. Signs are used pragmatically, being related to the options available in a given situation. This

adaptability of signs considerably enhances their utility.

AGENTIAL CUTS

Agential realism involves a mechanism referred to as the *agential cut*, a process that complements entanglement; whereas entanglement joins two or more systems together, a cut splits one system into two. This is what happens during measurement: before it is known what the outcome of the measurement is we have an entangled state, but after the measurement the observer and the object of observation can be considered separate.

A point needs to be made in this connection. In accord with Bohr's dictum that science is about what can be said about nature, in this picture concepts such as entanglement and cut are merely idealisations, abstractions. Nature is inaccessible in its totality, and we have to make do instead with such idealisations as fall within the scope of language.

DISCURSIVE PRACTICES

Consistent with this pragmatic view is Barad's concept of *discursive practices*. Signs may have reference, but mere referentiality is of no value: it is how signs are used that matters. The processes of sign usage are referred to as discursive practices. This usage of signs involves their systematic transmission to other systems and the corresponding system responses, in order that the organised activity that results should generate the desired collective behaviour. Feedback from the outcome of this organised activity can be used to modify the discursive activity that generates it so as to enhance the outcome. Discursive activity, in this way, plays the role of a powerful tool that can be used in a variety of situations. Furthermore, the overall corpus of discursive activity can itself evolve, which idea will form the basis of our account of the connection between the agential realism hypothesis and the physics of the laboratory.

FAMILIAR ANALOGUES TO AGENTIAL REALISM

Agential realism, logical though it may be, might seem to be implausible by virtue of the complex intertwinings that are involved, were it not for the fact that it closely mirrors what happens both in biological systems and in human activity. It must accordingly be considered a tenable hypothesis (later, it will be

argued that phenomena of the character of agential reality may arise naturally in situations where information has very specific consequences).

Taking the analogy seriously requires consideration of the ways in which agential realism and these analogues differ. Chemistry is an essential component of the hardware in the case of biological systems in general, while neural networks are in the case of human activity. But, as with computation, the hardware is not necessarily important. What is essential for agential realism to apply is a variety of features, such as structures that can be sensitive to specific signals and process information in specific ways, and can be subject to systematic modification by incoming signals. We take it that such features are supported in the situation of current interest.

Another perspective on the situation is the following. Physics is familiar with situations where order arises spontaneously. In the systems commonly studied by physicists, the order involved can be characterised in comparatively simple terms and, in contrast to the situation being considered here, are most often static in character. However, activity can present even in equilibrium in the form of fluctuations, which concept may be imported into the theory. What agential realism and its analogues may be telling us is that a more complicated kind of order, which is also dynamic, is equally possible, and may be prevalent in complex systems. Failure to recognise this order in physical systems may simply be a consequence of the wrong kind of focus (4).

EVOLUTIONARY AGENTIAL REALISM

Barad's primary goal was to derive a realistic account of quantum reality. Our aim is now to show how, when evolutionary processes are taken into account, agential realism can be linked to phenomena such the emergence of universes such as ours with its specific physical laws, as well as processes occurring within such universes.

We discuss first evolutionary mechanisms within the supposedly analogous situation of human culture. This can be characterised as the co-evolution of discursive and other practices, which mutually adapt to each other. The search for novelty can lead to new practices, associated with modifications of discourse, in some cases utilising the existing sign system but, where appropriate, involving an extension of the existing sign system, for example by

the invention of new words with the capacity to evoke new possibilities. Over time, radical advances occur in a culture through such mechanisms. Invoking the analogy, we argue that similar evolution can occur at our hypothesised deeper level, with the outcome being the production of universes, and processes occurring within these universes, through a rough equivalent to modern technology, it being rather as if some advanced civilisation had come into existence, as a result of organisational activity at the deeper level, and had developed its own version of our technology.

The details can be related to the *concerns* within a culture, which gradually change over time. Applying the same concepts to agential realism at a fundamental level has to take account of the fact that ‘concerns’ at such a level are, initially at any rate, very different from human concerns. These initial concerns must be related to the survival of any agencies that exist, as will involve some kind of primordial understanding of the environment, and of action within that environment. Evolution will involve what can be considered to be advances in such understanding, on the basis of the discovery of new possibilities, a process similar to cognitive development in humans. In essence, what is involved is the discovery, description and manipulation of *patterns*. The use of appropriate language can have the consequence of many agencies working together to create larger scale patterns, something that has its equivalent in human societies.

The question then arises as to which choices would be made, in this kind of scenario, out of a multitude of possibilities. A relevant possibility lies in the way discourse works. It may in particular involve the abstraction *goodness*, and concepts related to goodness, tying such concepts to *valuations of overall outcomes*.

Preferences relating to goodness would ultimately lead to particular outcomes being favoured.

AGENTIAL REALISM AND HUMAN CAPACITIES

The picture described above entails in addition the possibility of entanglement between processes in humans, and processes at the fundamental level. This may account for certain human capacities, including those relating to mathematics and music, it being difficult to see how the intuitive aspects of such capacities could develop in a refined form, in the limited time available for

human beings to acquire them. At the fundamental level, however, there is infinite time for the appropriate mechanisms to evolve, so entanglement with human nervous systems could lead to humans having contact with these mechanisms, thereby being able to make use of their implicit capacities. Music at the fundamental level might for example function as a symbolic system (cf. ref. 6), while mathematical capacities might emerge as a natural concomitant to processes dealing with patterns.

LINKS WITH THE POSSIBILIST INTERPRETATION OF QUANTUM MECHANICS

Agential Realism permits a reinterpretation of Ruth Kastner's possibilist interpretation of quantum mechanics (2), in accord with which the collapse of the wave function associated with observation is interpreted as the outcome of a *transaction* with a *possibility*, which outcome makes something definite, in the same way as in the present analysis. Possibilities are things that can be considered real, but are not necessarily *actualized*, which process Kastner equates with existing 'within the observable spacetime theater'. In this connection, Kastner and Barad both regard space-time as a structure that is *created*, not pre-existing.

The two views of reality can be reconciled by noting that the *transactions* of the possibilist interpretation are the equivalent of the *discursive practices* of agential realism, while the possibilities of the possibilist interpretation are also a part of discursive practice.

AGENTIAL REALISM FROM THE PERSPECTIVE OF PHYSICS

The kind of organisation proposed by Barad to account for the unusual characteristics of the quantum domain has been connected above with the kind of organisation found in human activity. In this section we discuss this order in more general terms, involving concepts similar to those developed in the context of biological systems in general by Hankey (private communication).

Physics is familiar with kinds of order such as ferromagnetism, where in the vicinity of a particular temperature some characteristic begins to propagate over large distances. This can be understood in terms of a positive feedback mechanism, whereby local changes affect the surroundings in a way that feeds

back so as to reinforce the original change, giving rise to an instability. With agential realism there is similar mutual reinforcement, resulting from interactions within groups of cooperating agencies. Differential reinforcement helps to determine which entities and practices are found in reality.

In a sense, then, agential realism is nothing new. What differs from the kinds of order familiar in physics is in part the complexity, but besides this there is the ‘entanglement of matter and meaning’ discussed by Barad. Once it becomes possible for specific information (for example signs) to relate to specific objects, as implied by Peirce’s semiotic ideas, everything changes.

That specificity can be attributed to the existence of specific structures that process information in specific ways. These structures are themselves organised by other structures, consequent upon the way discourse can rearrange the entities that it relates to. Thus nature discovers certain possibilities of self-consistent mutual organisation, and then extends and modifies them in dramatic ways.

CONCLUSIONS

There are some parallels between the present situation and what prevailed at the time when the atomic theory was being developed. The latter also provided a picture in terms of a hypothesised deeper reality capable of accounting, in simple terms, for a number of known phenomena that were, at that time, characterised in purely mathematical terms, with no underlying model. Taking the hypothesised deeper reality seriously led to considerable advances in science. Here, we are dealing with agencies that do more than collide with each other as the atoms of the atomic theory did (or, in the chemical context, bond with each other according to specified rules, so as to make molecules). In the present approach, these agencies are presumed to have internal structures, enabling them to interact meaningfully with each other on the basis of appropriate processing of information, so as to produce the observed phenomena.

It was argued in the final section that ‘meaningful interaction’ is the main factor making the hypothesised order involved in agential realism different from the kinds of order that are familiar in physical systems. If this is the case (and future research should be able to clarify this issue through the use of appropriate models), there would be the extraordinary implication (cf. ref. 2)

that developments in fundamental physics have been seriously limited through the view, largely accepted in mainstream physics, that the unpredictability that is characteristic of the quantum domain means that we should not think about what reality may lie beneath the surface. Barad, side-stepping this general belief, ingeniously followed through Bohr's analyses of quantum indeterminism to show that, for consistency, we are almost forced to a view of reality involving entangled agencies, interacting meaningfully as noted above. In this way, meaning has suddenly re-entered the picture, in a place where it had been assumed it would be absent.

The idea that meaning should not be mentioned in a scientific argument seems to be a one held fervently by many scientists, perhaps as a consequence of Monod's influential book *Chance and Necessity* (7). But disciplines such as language would be seriously handicapped were it not possible there to talk about meaning, and since language is a natural phenomenon it would seem irrational to insist in its exclusion elsewhere in science. Rather, the criterion for using the concept should be purely its *utility* in the situation at hand, and in Barad's picture of reality it plays a key part in discussing the role of discursive practices.

What should one conclude from this? Perhaps that dogmas such as those of Monod have no place in science, and can have a seriously inhibiting effect on its development. Freed from this constraint, we will encounter a whole new world to explore, integrating mental processing gracefully with the rest of science.

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