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DEBATE

AFTER CRITICAL REALISM?

The Relevance of Contemporary Science[1]

BY

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Abstract. While recent scientific discoveries and theories can be taken to provide additional evidence for some of the central critical realist claims, overall critical realism seems to be in need of reassessment, revisions and further developments. First, I argue that here has been an inclination among critical realists to prefer the language and model of philosophy to falsifiable science, creating a predisposition towards somewhat sectarian practices. These tendencies also account for the relative lack of substantive research based on, or inspired by, critical realism. Second, I make a case for radicalising the critique of anthropomorphism and applying it to critical realism itself. Third, and in some contrast to the second point, I argue for rethinking the subject–object relationship and the concept of the intransitive dimension of science. The critique of anthropocentrism has been taken too far. We are implicated in and are a part of the object of our study. It even seems that we humans are a part of the process of the cosmos becoming conscious of itself, also through science.

Keywords: anthropic principle, anthropocentrism, anthropomorphism, causality, cosmology, intransitive dimension, metaphor, philosophy of science, quantum mechanics, theory of relativity.

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Critical Realism: Out of Date?

For many readers of this journal, critical realism (CR) stands for the philosophy of Roy Bhaskar. CR was preceded by realist developments in the philosophy of science in the 1960s and early 1970s. In the 1970s, the key motivation to rethink natural sciences was to reconsider them as a model for social sciences. Roy Bhaskar's *A Realist Theory of Science* (1975) was followed by *The Possibility of Naturalism* (1979).[3] In line with similar attempts by several other social theorists,[4] Bhaskar developed ideas drawn from scientific realism to elaborate a critique of, and alternative to, positivist and hermeneutical modes of social sciences. Following Bhaskar's growing influence, the term 'critical realism' was subsequently coined in the late 1980s.

Realist Theory and *Naturalism* remain the basis for CR. The underpinnings of *Realist Theory* also guide concrete CR research on substantive issues. Unfortunately, substantive CR studies have been relatively rare in practice, by comparision with, for instance, positivist social science. Two decades after the term CR was adopted, most critical realists continue to iterate Bhaskar's criticisms of (post)positivist approaches to the human sciences, each in their own specialised academic field.[5] The response of students – including PhD students – to CR is indicative of the general tendency. In my experience, many of those students who become interested in CR do not apply CR ideas to doing better substantive research but, rather, are content to iterate Bhaskar's criticisms of positivist and post-positivist approaches, in spite of contrary advice.

To put it bluntly, the deep structures and narratives of CR appear in some ways similar to such nineteenth- and early twentieth-century scientific mythologies as those of Marx and Freud. These kinds of general theories have tended to evoke responses that are analogous to those of the religions which they tried to supplant. Modern scientific mythologies and their tendency to exaggerated self-confidence have been described vividly by Julian Jaynes:

> And [scientific mythologies] share with religions many of their most obvious characteristics: a rational splendor that explains everything, a charismatic leader or succession of leaders who are highly visible and beyond criticism, a series of canonical texts which are somehow outside the usual arena of scientific criticism, certain gestures of idea and rituals of interpretation, and a requirement of total commitment.[6]

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[3] Bhaskar 1997 [1975]; Bhaskar 1979.

[4] See especially Harré and Secord 1976. Although sceptical of large-scale sociological theory, it laid the grounds for Keat and Urry 1975 and for some of the basic ideas of Giddens 1976 and Giddens 1979.

[5] By and large, this is also true of some of my own works, such as Patomäki 1996 and Patomäki and Wight 2000. My first contribution to social theory was more critical in that regard; see Patomäki 1991.

[6] Jaynes 1990, 441.

Opponents have occasionally warned critical realists about over-reliance on a single authority or 'guru'.[7] It is also noteworthy that, to a significant degree, the foundational texts of CR – *Realist Theory* and *Naturalism* – have indeed been beyond philosophical and scientific criticism within the critical realist camp.[8] If my interpretation of CR as a canonical meaning-structure is even potentially plausible, it concerns especially the role philosophy plays in critical realism.[9] In theory, the role of philosophy is limited to analysing the ontological and epistemological presuppositions of contemporary scientific practices, or knowledge more generally; but in practice, a large part of Bhaskar's texts is dedicated to analysing the negative geo-historical consequences of various irrealist philosophies. This story-line reinforces the impression that CR claims are always well-defined, compelling and inevitable; and, on the other hand, it indicates that many of the world's problems stem ultimately from false philosophical positions.

Now, Bhaskar's examples of scientific experiments and theories date from the classical era of modern science, from the 1650s to the 1930s. Most of the examples of *Realist Theory* thus presuppose Newtonian or, more generally, modern linear science. The theory of relativity and quantum mechanics are discussed in *Realist Theory* only in passing.[10] Although the path-breaking early twentieth-century theories of physics do give credence to the CR idea of a movement towards explanatory depth, their role in shaping CR understandings of time, space and causality have remained rather nominal. Moreover, a lot has happened in science since the 1930s. Even for a social scientist like me, with a long-term interest in natural sciences, it is evident that the last three or four decades have seen leaps forward in theoretical physics, astro-

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[7] For instance, Hollis and Smith 1991.

[8] The second anonymous referee of my paper was critical and at times upset about my line of argumentation: 'Even Collier's 1994 introduction to Bhaskar contains many critiques of Bhaskar's arguments. Archer's works do as well. There are criticisms of Bhaskar everywhere. This is just a silly claim made by someone out to take potshots.' I have of course read Andrew Collier's introduction, citing it in this article as well, and many of Margaret Archer's works, including Archer 1995. However, it is a bit hard to see these studies as critical explorations of *Realist Theory* or *Naturalism*. First and foremost, both use Bhaskar's arguments against other approaches and conceptual frameworks (in *Realist Social Theory*, Archer's main target is Anthony Giddens), and only secondarily they may contain minor criticisms of particular details of Bhaskar's philosophy of science or social ontology. In Archer's own words, 'there is a considerable congruence between the TMSA and the M/M approach' (1995, 154) and, when describing what she is setting out to do, 'this undertaking appears to have Bhaskar's recent blessing' [despite some minor differences from Bhaskar's earlier formulations] (Archer 1995, 161).

[9] About the role of philosophy in theory, see Bhaskar 1997, e.g. 36–45, 52; Bhaskar 1979, 4–11, 17–22; and especially Bhaskar 1986, 10–27.

[10] But see Norris 2000.

physics, cosmology and life sciences. Sometimes these breakthroughs have revealed that science has been – and to a large extent remains – ignorant or confused about ultimate aspects of being. It should thus be no surprise that scientific advances have re-opened in exciting new ways old questions about causality, temporality and the origins and nature of the universe.

In this paper, I narrow CR to mean only the ideas developed in Bhaskar's early works *Realist Theory* and *Naturalism*. I argue, firstly, that recent developments in cosmology, physics and biology, including astrobiology, as well as theories of emergence and complexity, have made CR out-of-date in some important regards.[11] The point is not to replace CR with another philosophical position, or to launch an overall attack against the arguments of *Realist Theory* and *Naturalism*, but to show important ambiguities and limitations of CR and indicate a non-sectarian and future-oriented way forward. We should pose anew questions such as: What is the nature of causal laws, powers and mechanisms? What exactly is the status of the 'intransitive dimension' of science? Does intransitivity mean 'unchanging'? Are laws of nature really eternally unchanging or, alternatively, as radically disconnected from our subjectivity as Bhaskar claims? How should we understand our own being and subjectivity in relation to nature and cosmic evolution? Are we not deeply involved in, and part of, the object of our study?

However, whether some of the CR conceptions should be amended in the light of more recent developments in science is not the only important question. The question is also whether those working on the basis of realist philosophy of science should talk the language of science or philosophy – and practise more scientific research and less philosophy? There has been a strong inclination among critical realists to practise metatheoretical and philosophical critique at the expense of substantive research.[12]

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[11] Arguably, Bhaskar has incorporated ideas about cosmic evolution, complexity and emergence in his *Dialectic* and *Plato Etc.* These works include concepts such as world-lines drawn from the theory of relativity and they even develop – although only very tentatively – the possibility of futures studies, thus implicitly qualifying the earlier claim about the radical asymmetry between explanation and prediction. However, in *Dialectic* (or *Plato Etc.*) there is no systematic reassessment of earlier concepts and arguments but rather an indication that dialectical CR is simply a new and fully consistent layer added on top of the foundation of CR (i.e. *Realist Theory* and *Naturalism*). Moreover, there is no explicit dialogue with the contemporary sciences; Bhaskar cites and discusses explicitly only philosophy and social theory. See Bhaskar 1993; 1994.

[12] The second JCR referee (see n. 8, above) also wrote that 'this is an attack I have heard before without any substantiation, and it is simply factually untrue'. Thus when Petter Næss, for instance, writes in a recent issue of this journal that 'books focusing explicitly on critical realism as a vantage point for empirical research are still relatively rare', is he too making an untrue statement? (Næss 2008, 154). Indeed, I wonder how come this point is being made

Preference for Philosophy

In his *Critical Realism: An Introduction to Roy Bhaskar's Philosophy*, Andrew Collier explains the role of philosophy and the nature of Bhaskar's transcendental arguments.[13] He argues that 'a good part of the answer to the question "why philosophy?" is that the alternative to philosophy is not *no* philosophy, but bad philosophy'.[14] I agree; this is a solid point. However, CR has reserved a rather specific role and position for philosophy. Philosophy makes explicit and clarifies the knowledge that is already implicit in some practices, and in the case of *Realist Theory*, particularly in scientific practices. In a few clear sentences, Collier summarises the idea:

> It is the set of concepts implicit in the practice of the science, and which the scientists *qua* scientists do not need to make explicit, and may not even suspect that they use. Bhaskar does not derive his conclusions about the structure of the world from, for example, the theory of relativity, or quantum theory, or the theory of evolution. Attempts to do so are always blind alleys. But as we shall see, he is able to derive very far-reaching ontological conclusions from the practice of scientific experiment itself.[15]

The CR idea about the role of philosophy has two far-reaching effects. First it positions philosophy vis-à-vis science in a way that is reminiscent of the position of a naturalist Freudian psychoanalyst vis-à-vis his patients. The patients/scientists may not even suspect that they unconsciously use certain concepts or have certain experiences, but the analyst/philosopher nonetheless knows that they *must* be there.[16] As Jürgen Habermas has pointed out, this means that there is no need for a reciprocal dialogue between the two. Resistance to

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so often unless there is some truth to it? And there are reasons to expect a preference for philosophical theorisation. Inside the discourse of CR lies buried a set of practice-guiding assumptions: (i) philosophical truth is the key to successful human and social research; (ii) the paradigmatic exemplar of knowledge production is provided by Bhaskar's philosophy; and (iii) philosophical faultlines (i.e. geo-historical successions of false beliefs) are conceptually and causally (co-)responsible for many if not most of the ills that humanity is facing in the late twentieth and early twenty-first century.

13 Collier 1994, 16–25.

14 Collier 1994, 16.

15 Collier 1994, 17.

16 Here is some relevant textual evidence (my emphasis): 'the task of philosophy is to analyse notions which in their substantive employment have only a syncategorematic use. Thus whenever a scientist refers to a thing or event, structure or law, or says that something exists or acts in a certain way he *must* refer to it under some particular description; he is using the notion of thing, law, existence, etc. … The experimental scientist *must* perform two essential functions in an experiment' (Bhaskar 1997, 52–3). The formulation in Bhaskar 1979, 20, is even more straightforwardly naturalist-Freudian: 'Now it follows from my argument that scientists, when they are practising science, *are implicitly acting on transcendental realism. But it does not follow…that they realize they are*' (my emphasis).

accepting what the analyst says is usually due to distorted meanings and to the restricting agency of the conscious ego that controls speech and action. The reflections and opinions of patients can thus best be understood through the true theory, the validity of which is by and large independent of patients' opinions.[17]

Secondly, Bhaskar's and Collier's idea about the role of philosophy implies that the substance of scientific theories does not matter that much. The only things that really count are (1) that scientists do experiments in laboratories by creating artificial closures and (2) that experiments presuppose a differentiated, structured and layered ontology of mechanisms that are causally efficacious in open systems. While it is true that in argumentation the explication of opponents' practical presuppositions is legitimate, the assumption of CR seems to be that the presuppositions of the practice of experimentation are more important than the substance of scientific theories or their implications – or perhaps even more strongly, that the latter can mostly be ignored. Although Bhaskar acknowledges the constraint that 'in the long run philosophy must be consistent with the findings of science',[18] most critical realists have hardly paid any attention to developments in science. This inattention has deep roots. A quick look at the bibliography of *Realist Theory* reveals that Bhaskar's original work was based more on a dialogue with other philosophers than on engagement with the practitioners of science (it goes without saying that it did not involve empirical research on the practices of science). Thus in 1989 Bhaskar explained the nature of his arguments:

> [T]he account developed in *A Realist Theory of Science* is not supposed to be an exhaustive account of physics and chemistry, let alone all of the sciences: it is the hard core of a *philosophical* research programme, no more, no less.[19]

Given that Bhaskar aimed only at establishing a *philosophical* research programme, it is perhaps understandable that the lack of attention between CR and science has been reciprocal. For critical realists, philosophy is supposed to be the 'underlabourer' of existing sciences and occasionally the 'midwife' of new sciences.[20] CR should also work as a conceptual analyst and critique

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17 Habermas 1978, 246–73.

18 Bhaskar 1986, 13.

19 Bhaskar 1989, 183 (my emphasis).

20 In contrast to Bhaskar, for Steve Fuller (2006), 'underlabouring' indicates critical philosophy's subordinate relationship to the constrained, puzzle-solving sciences that have been preferred by conformists such as Thomas Kuhn and opposed by falsificationists and science-democrats such as Karl Popper (who professed conceptual critique and permanent revolution in science). Big science has obviously no need for a philosophical critique, although it may need 'underlabouring' in the sense of justification of what scientists are

of science. Yet CR has had hardly any impact on the sciences, except perhaps on a few small branches of biology and ecology. Scientists do not seem to have any need for CR underlabouring, midwifery or critique.[21] This does not mean that there are no scientists interested in conceptual, methodological, philosophical or ultimate questions. Many contemporary scientists are actively engaged in widely popular philosophical and even religious discussions concerning the origins, deepest structures and ultimate destiny of the universe, we humans included. An adequate explanation must thus lie, at least in part, somewhere else.

Moreover, although the basic idea of developing 'a non-anthropocentric ontology of structures, generative mechanisms and active things'[22] is for the most part reasonable, there is something remarkable about the way Bhaskar constructs his arguments. For instance, Bhaskar dedicates pages to a laborious philosophical discussion where he tries to demonstrate that the intransitive, ontological realm is categorically independent from both humans and events. He does not ground his argument on scientific theories of cosmological and biological evolution clearly affirming and testifying that there has been a universe without humanity, and that humanity has in fact emerged out of the universe over a (from a human perspective) very long period of time. According to contemporary science, complex society has emerged very recently and has existed only during a small fraction of the existence of humanity (less than 10,000 years out of 150,000–200,000 years), itself a latecomer in the long process of evolution.

It is therefore apparent that Bhaskar does not usually count scientific theories as relevant evidence for his ontological claims ('a transcendental argument…need not depend upon any particular theory'[23]). Nevertheless, at one point Bhaskar takes a Kuhnian interpretation of Albert Einstein's

doing. Indeed, critical thinking is absent from much of Kuhnian 'normal' science as 'most scientists are narrowly trained specialists who try to work entirely within their paradigm until too many unsolved puzzles accumulate' (Fuller 2006, 19) and who 'remain agnostic about the metaphysical significance of their inquiries' (p. 78). For critical thinkers, in contrast, 'science is philosophy by more exact means' (p. 58), i.e. love of wisdom that is important in its own right, based institutionally in the university and founded culturally on the republican virtues of free inquiry and free debate among equal scholar-citizens (pp. 107–8).

21 Paradoxically, this is implicitly admitted by Bhaskar himself. If scientists are doing – in scientific experimentation as well as more generally – the right thing anyway, independently of what they believe they are doing (cf. n. 16, above), they do not need CR philosophy to improve their practices. Thus Bhaskar's 'underlabouring' may in effect come close to Fuller's sense of Kuhnian conformism (see n. 20, above).

22 Bhaskar 1997, 45.

23 Bhaskar 1997, 244.

theory of relativity to support his criticism of empiricism and positivism. He maintains – citing Feyerabend as evidence – that 'we now know that the Newtonian system has been replaced and not just subsumed'.[24] However, this interpretation is somewhat inaccurate.[25] The theory of relativity retains classical Newtonian mechanics as an exact description of the physical laws as they appear when masses, velocities and amounts of energy are close to the level of humans' everyday experiences. For many practical purposes, there is no change of images that would be comparable to the difference between Aristotelian and Galilean dynamics. However, as I will soon explain, Einstein also redefined time and space and provided a new and deeper explanation for gravity in terms of curvature of space, thus dispensing with the idea of gravitation as a causal force or power. This is relevant for our understanding of causality.

Scientific Laws

In *Realist Theory*, Bhaskar provides a number of examples of scientific laws. These include Coulomb's Law, Ohm's Law, and Guy-Lussac's Law. As Bhaskar leaves these laws unexplained, and as most of his readers are social scientists or philosophers, a brief explanation of these laws is appropriate. I place the key words expressing causal metaphors in italics as they are relevant to the ensuing discussions. Coulomb's Law, developed in the 1780s by French physicist Charles Augustin de Coulomb, says that the magnitude of the electrostatic *force* between two point electric charges is directly proportional to the product of the magnitudes of each charge and inversely proportional to the square of the distance between the charges. A positive *force* implies a repulsive interaction, while a negative *force* implies an attractive interaction. According to Guy-Lussac's Law, discovered in 1802, the *pressure* of a fixed amount of gas at fixed volume is directly proportional to its temperature in kelvins. Finally, Ohm's Law – that was first found in 1827 – states that, in an electrical circuit, the *current passing* through a conductor between two points is directly proportional to the potential difference (i.e. voltage *drop* or voltage) across the two points, and inversely proportional to the *resistance* between them.

According to Bhaskar, laws are statements about the 'enduring and transfactually active mechanisms of nature'.[26] Bhaskar re-introduced not only Aristotelian essences but also the distinction between potentiality (*dynamis*)

24 Bhaskar 1997, 86; cf. 155.
25 See for instance Einstein's own clarifications in Einstein 2006 [1916].
26 Bhaskar 1997, 144.

and actuality (*entelecheia*) in the context of modern scientific laws. A mechanism is characterised by its potential for producing effects rather than by any actual regularities. All three examples cited above – exemplifying the late eighteenth- and early nineteenth-century science – testify to the correctness of this definition of laws as being about active powers, forces and/or mechanisms of nature that produce characteristic and well-defined local effects if and when triggered. In the context of real laws of nature, it must have thus seemed plausible to conclude that it is the task of philosophy to argue that some real forces or powers and mechanisms must exist; and it is up to science to discover what those forces and mechanisms are.[27] However, things have become more complicated since the discovery of Coulomb's Law, Ohm's Law and Guy-Lussac's Law, with important implications to our understanding of causality.

In different ways, both the general theory of relativity and quantum mechanics indicate that Bhaskar's definition of laws may in some ways be misleading. In general relativity, the effects of gravitation are ascribed to spacetime curvature instead of a force. Einstein proposed that spacetime is curved by matter, and that free-falling objects move along locally straight paths in curved spacetime. Einstein also discovered the field equations of general relativity, which relate the presence of matter and the curvature of spacetime and are named after him. The Einstein field equations are a set of ten simultaneous, non-linear, differential equations. What these non-linear

[27] In a plausible reading of *Realist Theory*, a mechanism is distinct from a law as a rule or regularity of action that, in physics and several other sciences, can be expressed mathematically and tested against carefully measured observations, experimentally or otherwise. A mechanism is what a thing is capable of doing, or being acted upon, if it is triggered and not prevented by something else. Mechanism is thus both a wider category than force and a deeper category than law. However, this raises the question of the exact meaning of 'mechanism'? It is not really specified anywhere. Bhaskar 1997, 85–6, is critical of Newtonian-Humean mechanics, but I suspect that if the concept of mechanism is cut off from its usual association with mechanical forces and material-efficient causation, and from the standard analogy to the working of machinery, the concept of mechanism comes, tautologically, to mean any scientific explanation. To explain something in terms of causal mechanisms would just mean to explain, nothing more; the word 'mechanism' would be redundant. Thus 'mechanism' and 'mechanistic' or 'machinery-like' must be linked. In any case, it is hard to see why there should be a single overarching concept defining the logic of all scientific explanations. Surely, as Bhaskar himself in various places indicates, many realist concepts are equally relevant, including action, force, power, causation, movement, process, relation, structure, system, field, (self)production, function, reason and purpose and epistemological concepts such as analogue, metaphor, model, narrative and scenario, just to mention a few. In the social sciences, I have argued that the concept of a causal complex is generally more adequate than mechanism, although the latter has some applicability too. See Patomäki 2002, ch. 4.

equations mean is that in Einstein's theory gravitation is not a force of attraction between two bodies but a property that can be described in terms of fields, implying the relative priority of the whole over its parts.[28] This is an important example of scientific theory replacing the assumption of causal force, based on common human experience, with a new metaphor that at first seems remote from everyday experience.[29]

On the other hand, in the quantum field theory, at the subatomic level, the gravitational interaction is mediated by hypothetical particles called gravitons, instead of being described in terms of curved spacetime as in general relativity. Within the limit of the classical mechanical world that we usually face on Earth and within our solar system, both approaches give exactly the same results, including Newton's laws of gravitation. However, we do not know whether gravitons exist. They are next to impossible to observe because of the weakness of gravitation when conceived as a force.[30] In any case, a key point is that general relativity and the so-called standard model of subatomic particles and quantum fields remain incompatible despite years of efforts to unify them. 'The notion of a smooth spatial geometry, the central principle of general relativity, is destroyed by the violent fluctuations of the quantum world on short distance scales.'[31]

Moreover, quantum mechanics[32] also has implications that defy the standard CR definition of laws in terms of powers and mechanisms of nature that produce characteristic and locally well-defined effects if and when triggered and not prevented by anything else. The famous wave/particle duality – quanta exhibit characteristics of both particles and waves – unites two seem-

[28] See Jammer 1999, 209–13.

[29] This is acknowledged by Bhaskar 1997, 226: 'Now the things posited by science in its investigations may be quite recondite and abstract with respect to our ordinary experience. It is wrong to think of them as necessarily like material objects – they may be powers, forces, fields or just complex structures or sets of relationships. Their metaphysical character, which justifies us labelling them as "things" to mark their insusceptibility to analysis as "events" or "experiences", lies in their persistence and transfactual activity.' However, this acknowledgement implies (i) that the concept of generative mechanisms operating in open systems does not provide the ultimate key to understanding the logic of scientific explanation and (ii) that philosophy is toothless in setting the terms for scientific investigations. It is really up to the scientists to do the required conceptual work in the context of substantive research.

[30] However, gravitational waves may give indirect evidence of them. A gravitational wave is a fluctuation in the curvature of spacetime which propagates as a wave, travelling outward from a moving object or system of objects. Gravitational waves from a pulsar have been observed empirically. See Greene 2000, 11–12.

[31] Greene 2000, 129.

[32] For an excellent history of the development of quantum mechanics, see Kragh 1999, chs 5 and 11–15.

ingly incompatible metaphors. However, the assumption of this apparent duality has led to a precise, though ultimately probabilistic, mathematical theory that has been successful in explaining and predicting previously unaccounted phenomena with a high degree of precision.[33] The problem is how to interpret the quantum equations.

Quantum mechanics seem to imply the lack of deterministic local causality. For instance, the wave function – the values of which give the probability distribution that the system will be in any of the possible states – appears to indicate that a single subatomic particle can occupy numerous areas of space at one time. Moreover, because of the probabilistic logic, particles can, albeit only with a small probability, emerge from nothing at all, as well as show behaviour that indicates movements backwards in time. Alternatively, these particles can communicate instantly across distances, thus violating the universal limit of speed *c* (the speed of light) and thus causal world-lines, or at any rate show clear evidence of non-local causality. Whatever the interpretation, it is clear that something of the classical notion of causal mechanisms operating within unidirectional time and the limit of the speed of light has to be relinquished or at least drastically reinterpreted.

I agree with Bhaskar that the standard Copenhagen interpretation of quantum theory has ignored the future process of science and the possibilities of developing causal models of those mechanisms that for a time were missing entirely, and still seem to be lacking to an extent.[34] However, the point remains that quantum theory – like general relativity – has substituted the notions of causal force and mechanism that have continuous and locally well-defined effects for a set of new ideas and metaphors that seem remote and at least in some ways weird compared to everyday human

[33] Quantum mechanics originates in the empirical anomalies of previous theories. In the studies of black body radiation at the dawn of the twentieth century, it was quickly realised that the Wien-Planck law was only an imprecise approximation of empirical observations but not an exact law. Planck's law, published in 1901, was a response to this empirical anomaly. Planck's law described spectral radiance as a function of frequency, temperature of the black body, and several constants of mathematics and nature. In order to explain why his somewhat ad hoc formula works, Planck was soon led to posit an instrumentalist hypothesis that the electromagnetic energy could be seen as being emitted only in quantised form. More daringly, in 1905 Einstein proposed a hypothesis of light quanta as real but discrete entities that could explain the photoelectric effect. Thus it was Einstein who introduced the wave/particle-duality and triggered the development of quantum mechanics. Because of its radical implications, it took years before Einstein's quantum hypothesis was taken seriously by the mainstream of physics. Kragh 1999, ch. 5.

[34] Bhaskar 1997, 61. For a philosophical discussion and defence of realist interpretations of quantum mechanics, see Norris 2000; for an outline of a well-known but contentious causal-realist interpretation, see Bohm and Hiley 1993.

experiences. The empirical success of the theory means that it cannot be ignored by philosophers of science.

Radicalising the Critique of Anthropomorphism

My reading of the philosophical implications of these early twentieth-century theories of physics is that they point towards the importance of radicalising the critique of anthropomorphism characterising so much of science and philosophy. CR has been rightly critical of the anthropomorphism of Western philosophy but many of its basic concepts such as active causal forces and mechanisms of nature seem nonetheless to be based, metaphorically, on very ordinary human experiences. I agree with John D. Barrow that both science and philosophy have tended to rely on refined images and metaphors of basic human intuitions and categories of thought: 'One suspects that a good many more habitual concepts may need to be transformed before the true picture begins to emerge'.[35]

Humans reason principally through metaphors.[36] Abstract concepts, such as causality or causal laws, are based on complex metaphors. Bhaskar is explicit about the role of images, analogues and metaphors in scientific modelling, but does not recognise their role in philosophical argumentation. This is one aspect of CR's privileging of philosophy over science, and it contributes to CR's positioning in relation to science in a way that is reminiscent of the position of a naturalist-Freudian psychoanalyst in relation to his patients.[37] To explicate the importance of metaphors not only in scientific modelling but also in philosophical theories, a few concepts of cognitive science must first be introduced.[38]

The most basic is the concept of category: 'every living being categorises; even the amoeba categorises the things it encounters into food or nonfood, what it moves toward or moves away from'.[39] In the course of evolution, we have evolved to categorise. Most categories are formed automatically and unconsciously as a result of our functioning in the world.[40] There are literal concepts – for example, the basic-level concepts – and the spatial-relations

35 Barrow 2007, 92.

36 While language, reasoning and metaphors preceded the emergence of reflexive consciousness, the latter seems to have developed from a series of new complex metaphors and related emergent brain structures. For an underrated but brilliantly original, thoroughly researched, and beautifully written history of the emergence of consciousness through spatial and other metaphors in the first millennium BC, see Jaynes 1990.

37 Bhaskar 1997, 194; Bhaskaar 1979, 15.

38 From Lakoff and Johnson 1999.

39 Lakoff and Johnson 1999, 17.

40 Lakoff and Johnson 1999, 18.

concepts. The basic-level categories stem from body-based properties (possibility of mental images, perception of overall shapes, ready-made motor programs). The division between basic-level and non-basic-level categories is body-based, that is, based on gestalt perception, motor programs and mental images. There are also basic-level actions ('walking', 'swimming'), social concepts ('family', 'football club') and emotions ('happiness', 'anger', 'sadness'). At the basic level, there is a close correspondence between our categories and the divisions of the world.

The rest of our reasoning is based on metaphors. Metaphors stem from a mapping of one area (source-domain) that is used to reason about another set of data (target-domain). Each metaphorical idiom comes with a conventional mental image and knowledge about that image. Examples of primary metaphors include: Affection is Warmth, Important is Big, More is Up, Categories are Containers, Similarity is Closeness, Change is Motion, Time is Motion, Purposes are Destinations, etc.; 'early conflations in everyday experience should lead to the automatic formation of hundreds of primary metaphors that pair subjective experience and judgment with sensorimotor experience'.[41]

Complex metaphors are formed from primary ones through conventional conceptual blending. Complex everyday metaphors are built out of primary metaphors, plus forms of commonplace knowledge (folk theories, widely accepted knowledge and beliefs). The meaning of the whole (complex metaphor, a metaphorical idiom) is *not* a simple function of the parts. The relationship is complex. Abstract concepts are typically structured by more than one conventional metaphor. This applies also to causality and causal laws. We reason about events, structures and causes by metaphors stemming from everyday bodily experience. Consequently, there is neither a single, literal concept of causation nor a single literal logic of causation that 'characterises the full range of our important causal inferences'.[42] Thus:

> The causal uses of verbs like *bring*, *throw*, *hurl*, *propel*, *drag*, *pull*, *push*, *drive*, *tear*, *thrust* and *fling* are not mere linguistic curiosity, a supply of many words for the same thing. The point is that these verbs, in their abstract causal senses, do not all name the same concept. Each names a somewhat different concept – a different form of abstract causation. Each has its own logic, somewhat different from the others. And each is the product of a form of forced movements mapped onto the abstract domain of events.[43]

41 Lakoff and Johnson 1999, 49.
42 Lakoff and Johnson 1999, 171.
43 Lakoff and Johnson 1999, 186.

The causal uses of many of these verbs are based on the Causation is Forced Movement metaphor, which is in accordance with the modern scientific way of seeing causation primarily as material-efficient causation. In a sense, however, Einstein's general relativity explained gravitation more in line with a mixture of Aristotle's categories of material and formal causes, whereby mass and energy (parts) form the relevant spacetime fields (the whole) and thereby constitute the natural lines of non-forced movements of bodies.[44] Thus Einstein's explanation of gravitation does not follow the notion of active forces and generative mechanisms of nature that produce characteristic and well-defined effects. Einstein also proposed the metaphor of field to replace that of forces and mechanisms.[45]

A few decades after Einstein, physics has concentrated on cultivating a new metaphor of vibrating strings as the ultimate constituent of reality – with the implication that there are in fact 10 or 11 dimensions instead of the usual 3 + 1 that we can directly experience.[46] Moreover, as twentieth- and twenty-first century science has introduced a series of new metaphors, often remote from human common sense, it has become clear that even when mathematical laws are very accurate and make powerful technologies possible, the underlying explanatory metaphors stemming from human bodily and terrestrial experiences can remain ambiguous and contradictory – suggesting a significant degree of ignorance and providing a good reason to keep the field open for new metaphors.[47]

44 Although formal and final causality are absent from *Realist Theory*'s account of nature, it does discuss the Aristotelian scheme of four different causes in the context of science itself, conceived as work and production (Bhaskar 1997, 194). For an excellent attempt to re-introduce all four types of causality to critical realist social-scientific ontology and methodology, see Kurki 2008.

45 Bhaskar 1997, 85, points out that 'the structure of a field or the organisation of an environment may be the cause of what is happening in it', but leaves it at that. This point notwithstanding, the concepts of field and organisation, while central in e.g. Pierre Bourdieu's theory, are not part of the canon of critical realism. Most critical realists have taken the concept of generative mechanism as the key to understanding scientific explanation. One indication of this is that 'field' or 'organisation' cannot be found in the indexes of any of Bhaskar's books, whereas 'mechanism' is extensively discussed, especially in *Realist Theory*. I have checked a number of CR (text)books and none of them indexes 'field' or 'organisation', while 'mechanism' is a key term in most of them. This applies also to Hartwig, ed., 2007. In *Reclaiming Reality*, Bhaskar articulates the CR idea of explanation in a characteristic manner: 'Knowledge, then, has "intransitive" objects which exist and act independently of it. But it is itself a social process, whose aim is the production of the knowledge of such objects, *that is, of the mechanisms of the production of phenomena in nature*' (Bhaskar 1989, 68, my emphasis).

46 See for instance Greene 2000; and for a criticism that string theory has failed to produce any verifiable or falsifiable claim whatsoever, see Woit 2007.

47 For this reason, Lakoff and Johnson 1999, 92, argue that a universal theory of all

Hence, the concept of mechanism does not have universal validity as a guide to scientific explanations (depending of course also on the exact meaning of 'mechanism'[48]). Over-reliance on the simple metaphors and concepts that have constituted the classical-modern Western idea of causality and causal laws is one of the reasons why CR – especially when it follows the nineteenth-century exemplars of successful science – appears to be increasingly out of tune with major aspects of contemporary science. As Lakoff and Johnson argue, 'One must learn where metaphor is useful to thought, where it is crucial to thought, and where it is misleading. Conceptual metaphor can be all three'.[49]

Eternally Unchanging Laws?

Historically the talk about causal *laws* has been associated with the idea of God as the ultimate lawmaker.[50] Laws regulate actions of people or, by extension, things. In the grand monotheistic religions that emerged in the Axial Age[51] it has been widely assumed that 'things are governed by a logic that exists independently of those things, that laws are externally imposed as though they were the decrees of a transcendent divine legislator'.[52] For Bhaskar, a key point has indeed been to refute that natural causal connections are dependent on humans or otherwise contingent. Bhaskar argues that causal connections are naturally necessary, transfactually efficacious and intransitive.

Arguably, the terms transitive and intransitive were taken from grammar (transitive verbs can take direct objects whereas intransitive verbs cannot), but that does not clarify the meaning. The original main meaning of the term 'intransitive' was simply 'that [intransitive things] exist independently of all human activity'.[53] In *Realist Theory*, 'transitive' is often used almost syn-

aspects of physics is unlikely and that the field will be characterised by a plurality of at least partly incompatible metaphors.

48 See n. 27, above.

49 Lakoff and Johnson 1999, 73.

50 The Code of Hammurabi (and related codes of law in the ancient Near East, some of which were a bit earlier) preceded the emergence of science by a millennium; it is thus plausible to assume that the laws of nature were modelled on human laws. In Graeco-Roman thinking, for instance, it was common to assume that the universe is a vast city-state with one constitution, which is the right reason or law of nature, and is contrasted with the positive laws of various states; see Horsley 1978, 36–7. Modern natural law theories have continued to apply this conception of natural laws to the rules and laws of society as well.

51 By Axial Age Karl Jaspers referred famously to the period from 800 BC to 200 BC; see Jaspers 1961.

52 Barrow 2007, 18.

53 Bhaskar 1997, 35.

onymously with 'changing' or 'processual', for instance 'it was discovered a posteriori, in the transitive process of science'.[54] Originally the Latin prefix 'trans-' referred to 'to pass over' (beyond, across); closely related terms include 'transit' and 'transition', both indicating movement or change. By contrast, 'intransitive' would thus seem to indicate endurance or even permanence. In many passages, the impression given is that at the level of physics, the laws, structures and mechanisms are unchanging, although change is ubiquitous at higher levels:

> It is of course possible that the nature of some particular will be transformed: in which event, scientists will search both for an underlying substance or quasi-substance which preserves material continuity through change…and for the agent or mechanism which brought about the change… Changes in things, I have argued, are explained in terms of unchanging things. The world is stratified. We need only worry about whether atoms will cease to exist when tables and chairs do; we need only worry about whether electrons will cease to exist when atoms do.[55]

While many fields may thus be historical and changing, Bhaskar's formulations leave open the possibility that at the most fundamental physical level, reality is unchanging. Intransitivity would thus indicate not only endurance and independence from the human subject, but also categorical permanence. In *Naturalism*, the definition of the intransitive dimension of science becomes rather ambiguous. As there is no question of intransitive meaning independence from all human activity, it would seem that the definition must be narrowed down to existential independence from a given scientific activity at a given moment in time. In my reading of these passages,[56] in the social sciences 'intransitivity' refers to the past, which must remain unchangeable, or to the future within which social-scientific subjects cannot (yet) alter the existential constitution of the objects of study, i.e. social agency and structures.

> I want to distinguish such *causal interdependency*, which is a contingent feature of the process concerned, from *existential intransitivity*, which is an a priori condition of any investigation and applies in the same way in the social, as the natural, sphere. For, although the processes of production may be interdependent, once some object O_t exists, if it exists, however it has been produced, it constitutes a possible object of scientific investigation. And its existence (or not), and properties, are quite independent of the act or process of investigation of which it is the putative object, even though such an investigation, once initiated, may radically modify it.[57]

54 Bhaskar 1997, 210.
55 Bhaskar 1997, 205, 208.
56 Bhaskar 1979, 60–1.
57 Bhaskar 1979, 60 (original emphasis). Arguably, insistence on the intransitive dimen-

Existential intransitivity is thus relativised to the moment of initiation of a research project; and it is argued that intransitivity in relation to that moment entails immutability and thus unchanged reality. Given the loose association between 'intransitive' and 'unchanging', CR can be plausibly claimed to be based on the assumption that the laws of physics and the mechanisms generating them especially are given, naturally necessary and thus unchanging (although emergence from them must of course be possible). In other words, the ultimate laws of nature would be expected to remain what they are, as necessary and unchanged, no matter what the subjects of science are or do.

However, what exactly is meant by necessary and unchanging in this context? Bhaskar's examples – usually mentioned in passing rather than discussed – are mostly from nineteenth-century physics and chemistry. Those laws and related mechanisms and fields may appear necessary and unchanging given the human terrestrial realm and humanly relevant scales of time. However, the question is: where do the causally powerful physical things and structures come from? To what extent, and in what precise sense, would they be eternally unchanging? And why? My argument is that CR does not take questions about being far enough. Do the ultimate laws of nature and related causal things (however conceptualised) pre-exist the universe – or perhaps even God if God in some sense exists? Where do they come from? Why are they what they are? Can they change? These questions cannot be answered by studying the presuppositions of scientific activities.

For science, in contrast to philosophy, these are in part empirical questions. Paul Dirac proposed in 1937 that gravity must be weakening as the universe grew older. Decades later, exact measurements have become possible. There is now evidence suggesting that gravity cannot change more than 3 parts in 10^{11} per year but even slower change cannot be ruled out.[58] Recently, there has been a claim, albeit controversial, that the strength of electromagnetic force has changed very slightly.[59] It has been possible to exploit big telescopes and new detector technologies to look at how different chemical elements absorb light from distant quasars. The results indicate that the value of the so-called fine-structure constant that characterises the strength of the electromagnetic interaction – and can also be taken to represent the strength of the interaction between electrons and photons – was slightly smaller in a distant past. The constant seems to have varied, even if only very slowly, in a

sion of the social sciences may easily lead to the underestimation of the importance of reflexivity and the role of scientific knowledge in constituting everyday practices in twentieth- and twenty-first-century societies.

[58] Rees 1997, 235–9.

[59] Davies 2006, 200.

particular era of the universe's history, from when it was about 300,000 years old until it was about 9 billion years old.[60]

According to contemporary science, our universe has evolved historically. The theory of the Big Bang first appeared in the 1930s. By the early 1970s, following various empirical anomalies of the steady state theory and the discovery of the cosmic microwave background radiation, it was widely agreed that the idea of a sudden beginning of the universe has been sufficiently confirmed. Since then the theory has seen some further breakthroughs, although it is still certain only to a degree.[61] According to this theory, the whole of the universe is still glowing – at low energy levels – from the original Big Bang. In the beginning of the flow of time some 13.7 billion earth-years ago, there was a huge expansion of space apparently from nothingness. One interpretation is that the latent energy of the faster-than-light expansion of space was converted into immense heat and a small universe of radiation only. At first, the world was in a thermodynamic equilibrium and there was neither matter nor any differentiated physical forces. After the initial symmetry was broken in a fraction of the first second, the four basic physical forces (strong and weak interaction, electro-magnetic forces, and gravity) could begin to operate, and soon the first protons and then electrons emerged out of this heat following the formula $E = mc^2$ (or $m = E / c^2$).[62]

Following further cooling, in the first few minutes, these protons and electrons could actually form hydrogen (71% of matter) and helium atoms (28% of matter). For a long time, virtually no other matter existed (deuterium and lithium account for most of the missing 1%). The early universe was very simple, consisting mainly of only two kinds of atoms, and entirely dark. It took hundreds of thousands of years of further expansion of space, cooling down and concentration of matter due to gravitation before the first stars were lit. The rest of the matter now existing has been produced inside stars, and the heaviest elements, on which life also depends, in supernova explosions. The forces of physics, basic elements of matter, and chemical building blocks constructed from them have thus emerged, in this order, in the historical process of cosmic evolution.

Now, the constants of scientific laws cannot be derived from any existing mathematical or physical theory but have to be measured empirically. Moreover, the project of building a 'theory of everything' – from which

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60 See Barrow 2003, 258–68; Barrow 2007, 125–8.

61 See Kragh 1996; Longair 2006, chs 12–16. However, there are sceptics who argue that there are other ways of interpreting the background radiation and that the whole theory of Big Bang may be wrong. See Narlikar and Burbidge 2008.

62 Delsemme 1998, 19–21, 293–4.

these constants and laws could hypothetically be derived – is beset with fundamental difficulties.[63] There is thus a strong case for counterfactual reasoning: the constants of nature and laws could also be otherwise. If the constants in the basic laws of physics can assume any values, then the probability of our universe and its structures and causal laws being exactly like they are spontaneously appears to be very low, indeed close to zero. Moreover,

> the fact that our present-day Universe admits such definiteness is something of a mystery. As we look way back into the first instants of the Big Bang, we find the quantum world… From that state, where like effects do not follow from like causes, there must somehow emerge a world resembling our own, where the results of most observations are definite. This is by no means inevitable and may require the Universe to have emerged from a rather special primeval state.[64]

Ultimately, causal laws are thus contingent on something that we do not know – independently of how necessary and invariant they may appear from a short-term terrestrial human perspective, and despite some plausible speculations. This contingency raises further questions. First, is it possible that what we call the laws of nature are no more than local by-laws? Secondly, do laws remain the same in those areas of the universe that we cannot see (we can only see the distance of some 13.7 billion light years from Earth and thus also 13.7 billion years to the past)? Further, what is the guarantee that the laws will not begin to change in the long-term future? Should we detect changes, are there higher-order laws that would explain the past or future variation of the constants of nature and thus causal laws? For instance, Leonard Susskind maintains that the constants of nature and thus laws of physics and basic atomic structures are, in general, determined by various fields, of which the so-called Higgs field is the most important in indicating the range of possible variation. It is already within the reach of human technology to create a magnetic field that slightly alters the properties of the vacuum (Magnetic Resonance Imaging is routinely used in medicine; 'vacuum' stands for an environment in which the laws of nature take a particular form).[65]

At best, it seems that CR ontology of the 'intransitive dimension of science' is only applicable – with the qualifications and restrictions specified above – in the spacetime area approximately defined by the history of the Milky Way galaxy and particularly of our solar system in it. Contemporary science thus recognises that:

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63 See Barrow 2007; cf. Lakoff and Johnson 1999, 92.

64 Barrow 2007, 227.

65 Susskind 2006, 91–8.

- there seems to be contingency at the heart of the cosmic existence;
- within large timescales, the prevailing causal powers, forces, mechanisms and fields are emergent and may also be changing slowly; and
- they may be subject to (limited) human influence as well.

Nothing in the universe would seem to be outside the principles of evolution and change. A possible end-state of the long process of cosmic evolution is a world in which entropy has increased radically, stars died and matter disintegrated to form a cold and hugely expanded universe. Should that eventually happen, causal forces will cease to exist and causal laws become irrelevant. Although I think this apocalyptic scenario is likely to be false, the point is that there is no realm in which the distinction intransitive/transitive is absolute. At all layers of reality, 'intransitivity' – whether taken to mean permanence or independence from human activities – is relative and complex.

The Anthropic aka Biophilic Principle

Thus far I have argued that the common-sense categories of human terrestrial existence have been questioned by theories of relativity, quantum mechanics, and late twentieth-century astrophysics and cosmology. Contemporary science has generated new understandings of time, space and causality. General relativity has in effect re-introduced Aristotelian material-formal causality in explaining gravitation in terms of holistic fields. For the followers of Einstein, physical objects do not exist in a pre-given time or space but rather these objects are spatially extended; and time is understood in terms of multiple moving reference-bodies, none of which is privileged in any way. Quantum mechanics has, in turn, questioned the idea of local causality and the rules of special relativity (that there are no faster-than-light movements and that time flows unidirectionally).[66] Moreover, cosmology has become a

[66] These problematisations are implied by (i) the Einstein, Podolsky, and Rosen paradox, given the consistent results of various experiments; and (ii) causal-realist interpretations such as the Bohmian ontological account that explicitly defends non-local causality. For a non-realist, who begins with the Copenhagen interpretation, various other possibilities are open, some of which are ontologically radical or extravagant in their implications. The standard Copenhagen line is techno-instrumentalist and implies that the observer determines the values of a probabilistic and otherwise indeterminate quantum system. The moment of this determination is called 'wavefunction collapse'. The many-worlds interpretation explains the wavefunction collapse as a mere subjective appearance. The reality behind the apparent wavefunction collapse is that every possible outcome to every event defines or exists in its own 'history' or 'world'. In layman's terms, this means that there are an infinite number of universes and that everything that could possibly happen in our universe (but

historical science that has established, counterfactually, that the constants and laws of nature could be otherwise and that they may vary slightly across vast spacetime areas. In general, laws of nature may be dependent on various fields, which may vary and be shaped by human activities. In other words, Bhaskar's claim that laws of nature are intransitive, necessary and active mechanisms of nature producing characteristic and well-defined effects if triggered and not prevented by anything else has turned out to be a partial truth, not a general key to understanding all scientific explanation. Science does not proceed only by identifying enduring and active mechanisms of nature, although that has been an important part of the project of science.

In *Realist Theory*, Bhaskar also defended a categorical ontological distinction between the subject and object of science; this is the first and basic meaning of 'intransitivity'. Quantum mechanics has provided an often discussed counter-example: human observations necessarily shape the world at the quantum level of reality.[67] However, there seems to be another level at which the object of science seems to be strangely dependent on the subjects of science. The only universe we can see supports life and also our own being. On the basis of counterfactual reasoning, it has become more and more evident that if our universe was even slightly different, we would not exist to see it. 'Most significant changes to the laws of physics would be fatal'.[68] It seems that the laws of nature that we observe must be fine-tuned for the possibility of biological evolution and development of complex life-forms such as us. At the minimum, this seems to indicate that the Copernican principle – 'we don't occupy a privileged position in the universe' – has been taken too far by modern science and by philosophies such as CR advocating it.[69]

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does not) could also happen in another. It seems to me that this is a high price to pay for sticking to local causality, not least in terms of Ockham's razor.

67 In recent decades the quantum decoherence view has gained popularity; see for instance Zurek 1991, 36–44, and for an alternative realist interpretation, Bohm and Hiley 1993. The crux of the matter is that Schrödinger's equation – describing the space- and time-dependence of quantum mechanical systems – is applicable only to a closed system. A coherent superposition of alternatives is thus naturally lost in open quantum systems. Thus 'decoherence' can be taken to mean that coherence 'leaks out into the environment' or something similar. In causal-realist interpretations, however, particles are viewed as having definite positions and velocities. Heisenbergian uncertainty is explained in terms of chaotic behaviour of the underlying hidden variables (a system is chaotic if it exhibits dynamics that are highly sensitive to initial conditions).

68 Susskind 2006, 96.

69 My discussions with critical realists indicate that the mainstream of CR – relying largely on Bhaskar's *Realist Theory* and *Naturalism* – is paradoxically rather close to David Hume in its scepticism about the human onto-cosmological condition (paradoxically, because usually Hume plays the role of the main villain in CR stories about the history of science). According to a common interpretation, Hume mounted a sceptical attack on all forms

Already in the early 1960s, Robert Dicke noted that the age of the universe as seen by living observers is not random, but is constrained by biological factors that require it to be roughly a 'golden age'.[70] For billions of years the early universe was too simple for life as we know it to evolve, but much later the main sequence stars and stable planetary systems would have already come to an end. The term 'anthropic principle' was first coined by the theoretical astrophysicist Brandon Carter, in his contribution to a 1973 Kraków symposium honouring Copernicus's 500th birthday. Carter articulated the anthropic principle as a reaction to over-reliance on the Copernican principle, which states that we are not in a special position in the universe. 'Although our situation is not necessarily *central*, it is inevitably privileged to some extent'.[71] Carter defined two forms of the anthropic principle, a weak one which referred only to anthropic selection of privileged space-time locations in the universe, and a more controversial strong form which referred to the fundamental parameters of physics. According to the strong principle, supported by many apparent large-number coincidences, the universe must be such as to admit the creation of observers within it at some stage.[72]

The term anthropic principle refers especially to humans. However, the claim is merely that complexity, life and billions of years of evolution in stable circumstances must be possible for some observers like us – any intelligent life-form in whatever galaxy and solar system – to be here studying the laws of nature. The 'biophilic' principle might thus be more appropriate.[73] Anyhow, this universe and the laws of physics must at least be compatible with the possibility of development of complex life forms because we know that life on

of design arguments and teleological reasoning (e.g. Barrow and Tipler 1998, 69–72). However, Hume was not consistent in his attitude towards religion and also wrote things like 'the whole frame of nature bespeaks an intelligent author' (quoted in Gaskin 1993, 320). Although the fear of censorship and practical-political consequences might have made Hume write contradictory statements, it seems clear that as a consistent sceptic Hume was unable and unwilling to deny the existence of God. It should be noted that for the same reason he was far less opposed to causal realism than Bhaskar has let us understand on the basis of a few selective quotations. For a provocative discussion of Hume as a causal realist, see Wright 2007.

70 Dicke 1961, 440–41. John Barrow and Frank Tipler argue that the weak anthropic principle shows Dirac's original radical hypothesis of the weakening constant of gravitation G to be quite unnecessary. The anthropic principle and the question of invariance of the laws of nature are thus connected. Given the time and stability required for life to evolve, the anthropic principle provides a strong reason to believe in predominantly invariant constants and laws of nature (Barrow and Tipler 1998, 21).

71 Carter 1974, 291 (original emphasis), available at http://adsabs.harvard.edu/abs/1974IAUS...63..291C (accessed 14 March 2008).

72 Carter 1974, 294.

73 See Davies 2006, 149–50.

this planet, including we humans, exist. All four basic forces of nature are in many ways implicated in the life story. Changing the strength of any of them, even by a small amount, could render the universe sterile. For instance, if certain very specific nuclear resonances in the nuclear physics of carbons were a little different, then the heavier elements could not build up in the interiors of red giant stars. The universe would contain only hydrogen and helium, and life would be impossible. The list is long.[74]

If Einstein in effect re-introduced material-formal causality to modern physics, the anthropic principle verges on re-introducing final causality as well. This is also the reason why many scientists are sceptical of the anthropic principle. As Carl Sagan argued in his 1985 Gifford lectures, 'It is not difficult to see teleology hiding in this sequence of arguments.'[75] Following Charles Pantin's cautious suggestion,[76] many scientists have in the last decades been more confident in proposing a megaverse or multiverse and either a kind of cosmic lottery or something analogous to Darwinist selection mechanisms than in exploring the possibility of final causality in any sense. However, the assumption of a multiverse comes with the price of positing the existence of billions and billions of causally disconnected universes, or an infinitely large cosmos, which we can never directly observe except for the tiny bit where we happen to be located, and which necessarily includes, among other bizarre things, an exact copy of our world, or perhaps many copies of it.[77]

At any rate, there is something very special about our visible universe. Somehow, it appears, we are part of the form of cosmos and perhaps even one of its final causes, or *telos*, that the laws of nature seem to serve. Contemporary science has thus re-opened the question of a cosmic design (which is a meaning of formal cause, but not the only possible meaning) or constitution and purpose (which is the main meaning of final cause). However, this problematic is no longer left to philosophers and theologians. There are scientific ways of tackling many aspects of it. First, we may be able to find indirect evidence about the existence of other universes – if they do exist. Second, the counterfactual reasoning behind the anthropic principle may turn out to be unjustified if science eventually comes up with a 'theory of everything', i.e. a plausible and exhaustive account of the ultimate causes of the constants and laws of nature. Third, perhaps there is also a failure of imagination concerning possible forms of life in conditions that would be fatal to us? Astrobiology

74 See e.g. Davies 2006, 151–71.

75 Sagan 2006, 57.

76 Pantin 1965, 103–4.

77 For insightful discussions, see for instance Davies 2006, ch. 8; Rees 1997, 251–69; Susskind 2006, 293–376.

is one of the most rapidly evolving strands of science and it may be able to provide some answers in the next few decades.[78]

Conceptual work is also important; philosophy and theology can play important roles. However, rather than studying the abstract presuppositions of knowledge or laboratory experiments, philosophy could in this context help most by clarifying the meaning of formal and final causality. These concepts originate in Aristotle's *Metaphysics* (Book V) and *Physics* (Book II). Aristotle's discussion of formal and final causality is not always precise or clear and thus leaves a lot of room for diverse interpretations; it also relies on organistic metaphors that do not necessarily work well in the cosmic context. The point here is not to get Aristotle right but to explore the possibility of improving conceptual resources for thinking about the nature of the laws of nature and how they might be related to the form of cosmos or to the ends of cosmic evolution. The standard problem with teleology is that it does not respect the rule that causes must be prior to or contemporaneous with effects; and we also know that the success of modern natural science would not have been possible without reducing the appeal to formal and final causes. Yet, at the beginning there was no time. At the quantum scale, time may become just another spatial dimension. In that kind of a world, nothing is prior to or contemporaneous with anything else, and there is no simultaneity either. We also know that as long as quantum effects dominate (when the universe was very small), causality and time remain ambiguous.

Aristotle treats the whole, composition and form of an entity as a chief category of causality (in 195a of *Physics* and 1013b of *Metaphysics*). A possible way of utilising Aristotle's concepts would be to argue that at the point when time emerged as distinct from other spatial dimensions and started to flow, there could be no efficient causes, only material and formal causes. It is improbable that something in the available materials and composition or forms of things at the beginning of the flow of time would not have already contained the laws of nature and thus potential for life and biological evolution. Thereby the available materials and composition or forms must also have contained the potential for the development of emotions and reason, consciousness and intentionality. But could the latter somehow have caused the former? In *Physics* 198a Aristotle has an interesting comment on theories of the origin of the universe:

> Spontaneity and chance are causes of effects which, though they might result from intelligence or nature, have in fact been caused by something incidentally. Now since nothing which is incidental is prior to what is per se, it is clear that no incidental cause can be prior to a cause per se. Spontaneity

78 See e.g. Jakosky 2006.

> and chance, therefore, are posterior to intelligence and nature. Hence, however true it may be that the heavens are due to spontaneity, it will still be true that intelligence and nature will be prior causes of this All and of many things in it besides.[79]

Aristotle argued that spontaneous – i.e. efficiently self-caused – events or processes (*automaton*) cannot be prior to a cause per se. A twenty-first-century version of this argument might go as follows: no efficient causes or their conditions could have preceded the flow of time. However, (1) the material from which the latent energy from the expansion of space emerged and (2) forms that gave rise to the constants, laws and mechanisms of nature must have existed before time. Hence, explanation of the Big Bang and its consequences should refer to material-formal rather than to material-efficient causes. In other words, science cannot rely exclusively on material-efficient causes.

Moreover, formal causes and ends are closely linked. Frequently, Aristotle grouped formal and final causes together, as when he argued that 'since nature is for the sake of something, we must know this cause also' (198b).[80] Living nature and intelligence are prior causes of the universe because the universe has the properties essential to those ends and, somehow, the ends seem involved in the causes of those fundamental properties. Teleology is indeed hiding in the post-Aristotelian sequence of arguments but the question is whether this is an insurmountable problem or a way forward towards a plausible answer (which may or may not involve any sort of intentionality or conscious design).[81] A credible solution to this puzzle may also require

79 Aristotle 1992b.

80 Although the prevailing opinion in the Aristotle scholarship is that the form and the end typically coincide, as argued by Stephen Hawking, they are not the same. Form always constitutes (aspects of) being itself, whereas the end of a process often refers to something that is external to that being (Hawking 2007, 521–41).

81 A strong argument against deistic and especially monotheistic narratives about design is that all such arguments have failed in the past. In the course of the haphazard and always contingent rationalisation and collective learning of humanity and, recently, due to the development of modern science, there has been a tendency to push divinity backwards from the scene; deity has become more and more distant from the earthly life. The anthropic principle is perhaps the most distant and abstract of all possible interpretations of intelligent design, leaving the determination of everything after the beginning to natural mechanisms, processes, systems and fields; this has been roughly the position of thinkers from René Descartes to Paul Davies; see Barrow and Tipler 1998, chs 2 and 3; Davies 1990. Moreover, several versions of the anthropic principle do not presuppose any sort of design. Since Spinoza, many scientists and philosophers have argued against design as well as against all versions of final causes, although they have also argued for an abstract impersonal divinity or for a position of everything-in-theity; see Barrow and Tipler 1998, 59–60; Jammer 1999; Silk 2006, 218–25. A weak point in anti-theistic or a-theistic speculations about cosmic

further transformations of those habitual concepts and metaphors originating in our limited short-term terrestrial experiences. There is also a case for renovating the capacity for telling meaningful stories about cosmic processes and our role in them.

I thus disagree with Bhaskar when he writes that 'it is entirely accidental that we exist, and understand something about our bit of it'.[82] It is also not necessarily true that 'we can rest assured that long after mankind has perished things will persist and continue to interact in the world that we once lived in'.[83] Independently of whether life and humans really are the essential constituents of the formal and perhaps also a part of the final cause of the universe, life on planet Earth is clearly an outcome of cosmic evolution. Practically every atom of Earth and of our bodies originates in stardust – they come mostly from the remnants of a supernova explosion. Through the emergence and development of humanity, including the cultural construction of consciousness and coming out of modern scientific knowledge, the historically evolving cosmos has been becoming conscious of itself. Our human understandings, including our scientific theories, are part of the cosmic evolution of the universe from which we have emerged.

Contemporary science has thus problematised and relativised the Copernican principle and related ontological subject–object distinction on at least at two levels.[84] There are ways in which we seem to be at the metaphorical centre of the universe, after all. At the very small scale of uncertain quantum fields, out of which our stable everyday world emerges, observation is not a neutral act but part of the environment which interacts with the observed

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selection or lottery is that these presuppose the existence of something that cannot, even in principle, ever be observed. Thereby they also radically multiply beings, thus violating even the most cautious and qualified interpretation of Ockham's razor (cf. Norris 2000). Further, as I point out in the main text, what conceivable mechanisms could have worked prior to the emergence of time? However, for an interesting non-deistic design argument that involves the continuity of a – speculative but in principle also scientifically possible – fifth-dimensional time across an evolutionary series of universes, see Gardner 2003.

82 Bhaskar 1997, 250.

83 Bhaskar 1997, 208.

84 My conclusion here does not imply a commitment to any particular position or interpretation of the origin of the mechanisms, laws and constants of nature. Moreover, it should be stressed that I am not presupposing a general consensus among scientists that the Copernican principle should be abandoned or strongly qualified (cf. n. 20, above, indicating how big science is involved in instrumentalist expert systems and tends to be agnostic about the metaphysical significance of their inquiries). I am only presupposing (1) that a number of prominent scientists have questioned the standard interpretation of the Copernican principle and/or the subject–object distinction; and (2) that they have good reasons for doing so. We may be living through an era of a new scientific revolution, the effects of which will be realised more fully in the course of the twenty-first century and later.

probabilistic mechanisms. But more importantly, at all scales, the laws of nature appear fine-tuned for the existence of life and us. The CR concept of mechanism is not amenable to recognising the involvement of life and consciousness in the cosmic evolution. We are a part of the process of the cosmos becoming conscious of itself.

Conclusions

For one thing, contemporary science is relevant because it provides a model for scholarly investigations. Philosophy can no longer claim the role of a general regulator of conceptual work that is part of all scientific research. Although philosophical reflection and criticism have their legitimate moments in the dialectics of science, the capacity of these philosophical moments to enlighten and guide practices and understandings is limited. Moreover, philosophy has no monopoly over the deepest questions, and often seems unable to pose them. Philosophical critique and work is at times needed, but a philosophy can best show its worth by suggesting possibilities and informing better research practices that will over time yield significant new results. It is best to conceive philosophy not as a separate academic field but as part of all scientific activities.

Contemporary science has also problematised and taken further some of the ontological and methodological underpinnings of CR. Science is not only about identifying generative mechanisms – or causal structures or powers or forces – but often involves, firstly, redefining the explanandum, and secondly, specifying the material, formal and final causes of the explanandum. Even within the category of material-efficient causes, a wide variety of metaphors indicates different concepts of abstract causation. Moreover, although laws, powers, forces, structures, mechanisms, and fields of nature are transfactually efficacious, it must also be acknowledged that ultimately they could have been otherwise; and they may be, under particular conditions, otherwise. In the cosmic scales of time they may also be changing, albeit only extremely slowly; they may also be locally changeable, at least temporarily. The concept of 'intransitive dimension of science' is more multifaceted and ambiguous than previously realised; and the subject of science is part of the object in a complex way that is not adequately recognised by CR.

The categorical subject–object distinction fails to hold even in physics and chemistry. We humans are a part of cosmic evolution, possibly even an essential part. Somehow, it appears, we conscious human beings are implicated in and thus part of the very constitution of the laws of nature, possibly even representing one of the possible purposes they serve. This is relevant ontologically, scientifically, methodologically and ethico-politically, and should be explored critically and systematically.

According to Bhaskar, science – to stress, science rather than philosophy – is a necessary but insufficient agency of human emancipation from false necessities.[85] Emancipation is a planetary project of the human species. Emancipation means the altering of one mode of determination into a more wanted, needed or enabling one. In the CR account, nature and society are not opposed but part of the same continuum of intra-dependent reality. 'Thus not only are many "natural" ills and disasters socially produced, but social production may have absolute *natural* limits and conditions'.[86] In other words, natural and social sources of determination are very closely intertwined.

These points are of course well-taken. They could be taken even further: emancipation concerns all layers of reality and all scales of space and time. If anything, the task of critical sciences is to look towards desirable and feasible future possibilities of human–cosmic evolution – and indeed, take part in creating them. In this grand endeavour, mere philosophical critique is unlikely to play a major role.

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85 Bhaskar 1989, 191.

86 Bhaskar 1989, 6 (original emphasis).

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