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Beyond Materialism: from the Medieval Scholars to Quantum Physics

A traditional anti-metaphysical goal has been the materialist assimilation of human mental and personal qualities into the physical nature of the brain. However, consciousness notably resists explanation in such a way. In an attempt to deal with this problem, a firmly realist view of the laws of nature is argued here. Aspects of consciousness are examined, showing that consciousness does not lie within the remit of physics. A survey of the thinking of Descartes, Aquinas and Duns Scotus is given to illustrate the nature of the mind-matter and mind-body problem, with further reference to the position of Kant. By emphasising that physical objects comprise form and matter, the medieval philosophers provide a starting-point for a perspective that can incorporate modern developments in physics. It is proposed that the concept of the 'mental' be broadened to encompass the laws of nature, taken as mathematical ideas which determine the behaviour and properties of physical things. The identification of what 'matter' is raises significant questions, but may involve quantum fields. Eddington postulated what can be called a 'mental dimension', and this may provide a promising framework for uniting the laws of physics and our own mental nature. The main question is no longer the relationship between 'mind' and 'matter', for this is now at the heart of physics. It is more to do with human consciousness within this broader mental dimension.

Keywords: materialism, laws of nature, realism, nominalism, consciousness, ideas, epiphenomenalism, mind, matter.

Introduction

The nature and status of the mind have been the subject of deep debate throughout human history. During the late classical and medieval periods, the Church was the main guardian of scholarship in Western Europe, and discussions about the mind and the soul were unproblematic. However, since the seventeenth century, the most spectacular advances in human knowledge have taken place in the sciences. This has allowed strong challenges to be mounted against religious belief and indeed any kind of metaphysical belief.

The boldest claim is that all existence is accounted for in terms of the science of physics, a postulate known as materialism or physicalism: the entire properties and behaviour of any physical system arise, it is asserted, from the physics of its component elements. Now, human beings consider themselves marked by possessing qualities such as purpose, consciousness and moral responsibility, which in no clear way have anything to do with the atomic

physics of a biological system. A rigorous belief in materialism threatens to eliminate these qualities, leaving us as physical and chemical automata.[1] Such a view contradicts our deepest intuitions.

The aspects of our nature which are seemingly not physical have traditionally been associated with the 'mind', or 'soul', which in a poorly understood sense is associated with the brain. Receiving cognitive input through the brain, it exercises a degree of control over the behaviour of the brain and hence of the body. To many, however, the implication that there is a non-physical aspect to reality is highly troublesome, as is the failure to explain the connection between mind and matter. And indeed, a great deal of human behaviour that we might feel is caused by the mind is at least largely due to neurophysical phenomena in the brain. Hence mind-body dualism[2] is today a somewhat philosophically unfashionable viewpoint.

Modern dualism is usually seen as arising from the thought of Descartes in the seventeenth century. In the medieval period, however, various viewpoints were held which displayed a more integrated relationship between the mental and physical realms. These provide a starting point for the position put forward in the present paper, which is based on the following arguments. First, it is impossible to fit the nature of the conscious mind into the science of physics as we have it. Secondly, the concept of the 'mental' should be broadened to encompass 'ideas' in a sufficiently general sense to include the laws of nature, these being considered as formative entities which govern the existence and behaviour of material things. It follows then that the main problem is not, after all, the relationship between 'mind' and 'matter', for this relationship is now basic to physics. It is more about how human consciousness relates to this broader concept of mind as part of physics.

To argue this position, I first outline the materialist hypothesis being criticised. This is followed by overviews of the nature of physics and its laws, and of the distinctive nature of our consciousness. The later sections then develop the viewpoint outlined above, making special reference to quantum physics. No ultimate answers are of course claimed, but it is hoped that this at least provides a framework for improved discussion. I regard as quite hopeless those voices that seem to say that if we lack an explanation for how physics is related to the conscious mind, then the latter is a kind of unwelcome guest at the scientists' dinner party, and should either be ejected or compelled to change its identity.

Modern science and the materialist hypothesis

Modern science has achieved much of its outstanding success by adopting an

1 A view advocated notably by T.H. Huxley: see Fortnightly Review 95 (1874) 555; *Method and Results – Collected Essays*, Vol I, Macmillan, London, 1893.
2 A term first employed in the early eighteenth century by Thomas Hyde.

'analytical' approach to the understanding of complex physical systems. The properties and behaviour observed in the large-scale aspects of a system are accounted for in terms of those of its constituent parts. For example, what we call electric current is (in most cases) the effect of the flow of large numbers of electrons. The mass of a physical object is the sum total of the masses of its atoms. Its temperature derives from the atoms' energies of motion.

An important factor to this kind of understanding is the object's structure, namely how it is built up from its constituents. Diamond and graphite, for example, both consist of carbon atoms, but arranged very differently in the two cases. They thus have very different large-scale physical properties, such as density, conductivity and so on. Another relevant aspect to understanding an object is its history. Diamond and graphite are respectively formed through carbon being exposed to different conditions of heat and pressure. An electronic device comes into being initially through being designed. The anatomical form of a living organism has depended on the physical and biological environments encountered by the organism's precursors.

An object's 'environment' consists of those external factors which do not form part of it, and which may affect it. For an atom, this could be nearby atoms, local electric fields and so on. The environment of large-scale objects might comprise surrounding conditions of temperature, pressure, chemicals and other objects; these may also play a part in determining the environments of the object's atomic constituents. In the case of an electronic device, voltages imposed on terminals are to be taken as environmental factors.

An object's large-scale internal behaviour may be termed 'systemic' behaviour. For an electronic device, this could be the current patterns that produce voltages at output terminals, in response to voltages applied to its input terminals. For the brain, it could be patterns of neuron activity.

In the normal scientific view of a large-scale object, then, its elementary constituents – for example, atoms – behave according to the laws of physics, taking into account their local environments. The object's large-scale behaviour follows as a consequence, given its structure. Any description of the large-scale behaviour, including systemic behaviour, may be re-expressed in terms of its elementary constituents' behaviour and its structure. An element of randomness due to quantum effects may need to be allowed for.[3]

The standard materialist hypothesis is that the laws of physics are synonymous with the laws of nature, and are the *only* determining factors for the behaviour of anything in the universe, once its environment is known (if relevant) and once a set of initial conditions has been specified. This applies to systems of any size, even to the universe as a whole. Starting with the Big Bang, physical processes have given rise to all aspects of all things which have

3 Quantum theory also establishes the existence of physical systems that must be regarded holistically, such as atoms. The materialist viewpoint outlined here is unaffected by this.

existed. This includes their structures and physical environments. Everything comes about strictly by the action of the laws of physics, together with quantum randomness. Nothing additional, such as the 'human mind', acts: the latter is merely a label for certain physical phenomena in the human brain. Calling a particular set of brain processes a 'thought' is at best a convenient nomenclature, at worst a deception. The physical account is *always*, and *intrinsically*, complete. All alternative accounts can be dispensed with whenever we please.

Certain kinds of systemic behaviour may be highly interesting to us – such as patterns of neuron firings in brains, or electron flow in computers – and they may well follow special sets of rules within their context. Even so, they are no more than subsets of nature's total range of possible physical behaviour patterns. There is nothing *intrinsically* special about them, and the 'special rules' are merely contextual re-expressions of the laws of physics. In this way, materialism offers a unified description of nature and existence by denying anything 'different' about so-called mental phenomena. The term 'physicalism' is equivalent, and the term 'reductionism' is usually used similarly.[4, 5]

There are also many materialist/physicalist inspired theories, too many to discuss here in any detail, which try to associate a 'real' mind with a brain while retaining a causally closed physical universe.[6] Among these are type and token identity theories, functionalism, emergence, and supervenience theories. All suffer from the following defects: first, if the associated mind is non-physical it must not affect the physical, and so it must be epiphenomenal.[7] Secondly, there is still no *explanation* for the manifestation of a mind in a physical system – one of the major complaints held against dualist theories. Recent overviews have been given by Ludwig[8] and Chalmers,[9] while a detailed analysis of many of these theories has been given by Foster.[10] I go along with Foster's conclusions that authentic mental phenomena cannot be extracted from brain behaviour whose causative and ontological basis is purely physical.

Laws of nature

Since laws of nature play a strong role in the materialist philosophy just out-

4 It is beyond our present scope to give an extended discussion of the different types of reductionism. So-called bridge laws are required to connect the large and small scales of description; physicists normally employ the kind of analytic principle described here with the assumption that only this is needed. Thus additional bridge laws are either excluded or superfluous. Quantum randomness can blur the analytic 'bridge law', that is all.

5 Poole, M. *Science and Christian Belief* (2002) 14, 123.

6 For a recent anthology, see Stich, S.& Warfield, F.(eds.) *The Blackwell Guide to the Philosophy of Mind*, Oxford: Blackwell (2003).

7 See below for a discussion of epiphenomenalism. If the proposed mind is actually physical, then we have some kind of identity theory, as strongly criticised by Foster. The ensuing type conflict problems, insuperable in my opinion, are dealt with below in the section on consciousness.

8 Ludwig, K. in Stich, S.& Warfield, F.(eds.) *op.cit.* [6].

9 Chalmers, D. in Stich, S.& Warfield, F.(eds.) *op.cit.* [6].

10 Foster, J. *The Undivided Self*, London: Routledge (1991).

lined, and are likely to play a strong role in any alternative philosophy, we must examine the nature of these so-called laws. There are two major modern viewpoints on this subject:

(a) laws of nature are no more than human descriptions of observed regularities in the behaviour of nature; these empirical regularities are the fundamental reality and there is nothing underlying them;

(b) laws of nature denote real, substantive principles built into nature, and generating the regularities we observe. They determine nature's behaviour, and therefore provide an explanation for it.

These two viewpoints are known by various names. The first has been referred to as 'regularism' or 'Humeanism', since the philosopher David Hume was believed to have upheld it. The second has been termed 'necessitarianism'. However, it is interesting to note the similarity of thought between the first viewpoint and the medieval teaching of 'nominalism', the term I shall use here. It will suffice to refer to the second viewpoint as 'realism'.

The arguments for the two viewpoints have frequently been given.[11] For nominalism, the main argument is based on economy. Its adherents feel that we can do without any unobservable 'underlying principles' in nature, and they appealed to the medieval nominalist William of Ockham, who declared that entities should not be multiplied unnecessarily. It is pointed out that a number of tricky problems, such as how to treat sociological or mental processes, vanish if all is regarded phenomenologically and all the so-called 'deeper questions' are simply denied.

The justification for the realist position is that our experience and understanding of nature require it. The following arguments can be stated:

- Laws as 'real things' give *explanation* for a given object's manner of existence, behaviour and attributes, and why these are stable or changing with time.
- A realist and *universalist* view of laws explains why all objects of a given type have the *same* properties. For example the universe contains huge numbers of identical protons, identical electrons, and so on. Here we seem to have the choice of believing in the determining action of universal principles, or in massive coincidences, or in divine miracles.
- Relatively simple laws of nature frequently (and often in conjunction with each other) account for many and diverse sets of observations. The nominalist just has to appeal to coincidence again.

11 Tooley, M. (ed.), *Laws of Nature, Nature and Supervenience*, Garland Publishing (1999), (an anthology of some major points of view); F. Weinert, (ed.), *Laws of Nature: Essays on the Philosophical Scientific and Historical Dimensions*, Berlin: de Gruyter (1995), (a recent set of essays); Swartz, N. 'Laws of Nature', *The Internet Encyclopedia of Philosophy*, www.utm.edu/research/iep (2001)

- Small numbers of universal laws are conceptually more economical than many diverse sets of empirical regularities!
- Familiar and well-used terms such as causation or determination are meaningful only with a realist understanding of law in nature.
- If we can make rational statements about nature that are *true*, then they must refer to something rational within nature.
- We are able to rely on the behaviour of things that we may or may not choose to make happen – such as computers we could build, or spaceships we could launch. Our plans work, and realist laws of nature provide both a reason for this and a viable means of planning.
- Such laws also explain why some things may be *impossible*, which is not a category that can be derived from observation.
- Given knowledge of the relevant conditions now, laws of nature give accurate predictions of events in the future. Not having happened, these are not yet observable things. (Nominalists often assume tacitly that the future will resemble the past, but this is from their viewpoint illegitimate.)
- Much modern theoretical physics is based on ideas, and not on descriptions. It is believed to be a valid pursuit nonetheless!
- Useful theoretical ideas have often preceded observation, gone far beyond existing observations, or been based very loosely on observation.
- Overall, we feel that there ought to be a 'sufficient reason' for anything in nature. Although quantum random processes seem to be a partial exception, the existence of universal laws in nature provides this. It simplifies our picture of nature, and pushes our level of understanding back one step. Nominalism sacrifices our understanding of nature by saying that there is nothing there to be understood, but only to be described.

Note that it does not matter greatly whether we talk about 'natural laws', 'intrinsic properties' of things, or 'inbuilt principles'. These have similar deterministic implications, from a realist point of view. However, 'properties' need not necessarily be universal, whereas 'laws' by implication must be. It must be acknowledged that at preliminary stages of their investigations, scientists do often postulate nominalistic laws of nature as phenomenological attempts to summarise regularities in their observations. But the normal hope is to discover underlying principles which *explain* these.

I regard the arguments for realism as fully convincing. Philosophical economy is a valueless bauble if it ends up impoverishing our understanding.

More comments on nominalism and realism

Scientists in my experience are often somewhat inconsistent in their attitudes. In professional practice, they nearly always adopt a realist view of laws of nature. The latter are regarded in a substantive way, and related issues concerning causation and underlying explanation are firmly built into scientific discourse and procedure. Put on the spot, however, scientists will often insist that laws of nature are purely descriptive, and that they are nominalists. When the occasion passes, they revert to being realists again. It is like being married to someone but denying the relationship in public!

A further point is that deterministic materialism, as we have understood it so far, is obliged to rely on a 'hard', realist notion of natural law, since otherwise nothing is determined. We would even have no basis to discriminate between 'physical' and 'mental' phenomena. All are merely phenomena.

Christians and other believers might take note of some revealing comments made by the philosopher Norman Swartz.[12] In his view, 'Regularists' (i.e. nominalists), of which he is one, consider that 'Necessitarians' (i.e. realists) 'have merely replaced God with Physical Necessity' in making Laws of Nature into 'inviolable edicts imposed on the universe'. He continues:

> Such a view, Regularists claim, is simply a holdover from a theistic view. It is time, they insist, to adopt a thoroughly naturalistic philosophy of science, one which is not only purged of the hand of God, but is also purged of its unempirical latter-day surrogate, *viz*. nomological necessity.

If this is the motivation behind modern nominalism, the latter certainly has an agenda! However, from a theological point of view, it is ill-founded. The hand of God could still impose by direct fiat all the features of the universe that are observed. That, after all, is what the medieval nominalists believed.

Physics at different levels

Our understanding of the working of physics has undergone a radical transformation over the past century as nature has been probed at deeper levels. Some of the most important steps can be outlined as follows.

(a) At the large-scale level of our everyday experience, the dynamical behaviour of physical objects is given by Newton's laws, which state how material objects accelerate under forces. Various sources of force exist, for example electric, magnetic and gravitational fields. At this level, different solid objects cannot overlap in space. Physical quantities have determinate, well-defined values.

(b) At the atomic level, quantum mechanics becomes the basic theory of physics, and physical quantities are in general indeterminate. Newton's

12 Swartz, N. *op.cit.* [11]

laws reduce chiefly to Schrödinger's equation,[13] which determines the behaviour of the so-called 'wave-function'. This mathematical expression, when a physical attribute of an atom or elementary particle is to be measured – such as its position, energy or momentum – gives the probability of obtaining any given result. Wave-functions of different particles are able to overlap in space.[14]

(c) Underlying this is quantum field theory. An elementary particle is identified with an excited pattern of the quantum fields that exist at all points in space. Indeterminacy applies to the fields, to the particle attributes and even to the number of particles present. Interactions between fields give rise to forces between particles, and mathematical operators enable the calculation of the probabilities for various particle processes. There are equations governing the field quantities from which the particle's wave-function and physical attributes may be calculated.

Here there is a transition from the familiar world of hard, well-defined material objects into a somewhat abstract and insubstantial domain. At the everyday level our picture of matter appears clear-cut. Physical objects are experienced as self-subsistent, concrete things, with well-defined attributes. The laws of nature present themselves as conceptually distinct from the objects to which they apply. They are mathematical and deterministic, and at this level the 'materiality' of matter seems to have primacy. 'Matter' appears to be a well-understood and unproblematic concept.[15]

Proceeding into the quantum world, we find a strong element of 'controlled randomness', although all the numerical probabilities are precisely calculable. The mathematics of nature now seems to dominate; equations become our main tool for facilitating understanding and for making physical predictions. The 'materiality' of matter is somewhat elusive. Although quantum fields are able to have large-scale effects, particles are normally measured. But are the particles themselves 'real', or only the measurement-events? Is the wave-function 'real'? Physical quantities exist, but what possesses them? In fact the conceptual interpretation of quantum mechanics is still a matter of serious dispute. The mathematical formulae work, nevertheless, and without exception predict accurately the results from experiments. This allows the standard 'Copenhagen' interpretation to avoid assigning material reality to anything at

13 The so-called 'correspondence principle' is a kind of bridge law which states that Newton's laws must reduce to those of quantum mechanics, i.e. the latter generate Newton's laws when applied to large-scale systems. And this is so; however quantum theory is also able to *explain* many observations which were just 'facts of nature' in the Newtonian regime.

14 Thus, at extremely low temperatures, atoms can lie 'on top of each other' in space to form a so-called 'Bose-Einstein condensate.'

15 According to Ludwig, *op.cit.*[8], philosophers typically have this model of physics in their minds.

the level of quantum particles, except in a very general way.[16]

A reductionist approach to a piece of solid matter now seems to operate in a way opposite to that in which it works in biology. In biology, 'mental' qualities are commonly associated with living organisms – such as purposes and feelings. But by the waving of the reductionist's wand they are made to vanish; what remains is nothing but collections of molecules obeying the laws of physics. In modern physics, however, the situation is reversed. By the waving of the wand again, erstwhile 'solid matter' now metamorphoses into mathematics!

Clearly, the effects of waving wands may be a little deceptive. I am not really advocating that particle physics is a purely 'idealist' science, reducing the universe entirely to an assembly of mathematical ideas and concepts. Physical matter somehow exists as well as the equations, albeit much less tangibly than before. But a purely reductionist approach to biology – especially, of course, that of human beings – must surely be questioned.

The question of consciousness

The materialist account of human nature finds its most serious difficulty in the existence of consciousness. Can this be generated purely by the physics of the brain? How are we to incorporate the human belief in 'free will' or 'conscious agency' into our thinking? Certainly, a widespread opinion exists that physicalist principles will in the end answer all such questions. It is well exemplified by Dennett:[17]

> I would have thought a historical perspective alone would make [the non-materialist view of consciousness] seem ludicrous; over the centuries, every *other* phenomenon of initial 'supernatural' mysteriousness has succumbed to uncontroversial explanation within… physical science.

But such sentiments suffer from more than just optimism. Consciousness has qualities that make it radically different from anything in physics, even quantum physics. These may be summarised as follows.

- A conscious individual defines his or her own subjective world-view, which cannot be experienced from the outside. By means such as verbal communication I can correlate your experiences with my own, but I cannot experience

16 The Copenhagen interpretation allows us to talk about particles without asking any deeper questions about them, other than that they have certain fixed attributes such as mass and electric charge. There are no hidden mechanisms underlying quantum processes, and the quantum equations are taken as instruments for predicting the results of measurements in laboratory-scale apparatus, where the language of physics is held to be understood. Other interpretations of quantum theory exist, but those that differ greatly from the Copenhagen interpretation are highly controversial, and so far lacking in any experimental confirmation.

17 Dennett, D. in Metzinger,T. (ed.) *Conscious Experience*, Paderborn: Imprint Academic and Schönigh (1995).

your consciousness, since to do this I would have to be you. Physics, on the other hand, deals entirely in quantities that are definable and measurable objectively and publicly. There is no conceptual equipment in physics for *intrinsically private* things.

- There is no reference-point within physics for the conscious sensations themselves ('qualia'). Colours, musical notes, smells, pain, emotions and so on may well be *correlated* with the behaviour patterns of neurons in the brain, but they are not *definable* in terms of these or any other physical items. This is the so-called 'knowledge problem': knowledge of physics does not as such give you knowledge about conscious experiences. These are different kinds of knowledge.

Physics is therefore not enough. Dennett's logic is like that of someone who has up to now found all sheep to be white, and from this believes that an alleged 'black sheep' must surely be a mythical, nursery-rhyme creature! Of course it would be otherwise if consciousness were definable in physical terms. We have no convincing physical explanation as yet for ball lightning, but to call this phenomenon unphysical would be reckless, for it can still be described in the language of physics. Consciousness cannot. It is qualitatively different from the contents of physics; that is the crux of the matter.

The conscious mind as an active agent

There is more to the conscious mind than its cognitive aspects, however. Our experiential belief is that consciousness is not just a passive faculty but can also affect how we behave, a capacity often referred to as 'free will'. This presents fundamental difficulties for any kind of materialist position.

The aim of *epiphenomenalism*, as proposed by T. Huxley in 1874,[18] is to do away with these difficulties without doing away with consciousness itself. Consciousness is postulated as a side-effect (or epiphenomenon) of the brain's activity, without any additional effects of its own. No further details are offered. There seems to be little real evidence for this position, despite its popularity in different guises, but there are a number of arguments against it.

An objection first put forward by William James is based on Darwinian evolution,[19] and can be elaborated as follows. We take it that consciousness exists in humans but probably not in simple organisms; therefore it must presumably have evolved. For a feature to evolve successfully, it must benefit its possessor; so consciousness must have a useful function. But this means it must be a causal agent of some kind, or the means by which a causal agent acts. Thus, the mental must be able to affect the physical. And our experience indeed suggests that consciousness aids us in acting more intelligently and efficaciously, and also in the learning of new skills.

18 Huxley, T. *op.cit*. [1]
19 James, W. *Mind 4* (1879) 1.

A possible reply is that if consciousness were generated *automatically* by brain processes, it really might possess no function at all, and so the evolutionary argument would not apply. The difficulty here is justifying the automatic generation of consciousness. It is absent from most aspects of brain operation, after all. We can do a variety of activities with little or no conscious awareness, and people do surprising things while sleepwalking. Consciousness is something we can often choose to apply (e.g. to our breathing, to the feel of our clothes) or not. So the reply seems weak: it is not at all evident that consciousness happens automatically. Neither is its complex and coordinated nature readily compatible with coming about as an evolutionary accident.

There is a more fundamental point. If consciousness is an epiphenomenon, how can the brain have knowledge of it?[20] We talk and argue verbally about consciousness – but word-formation is a brain activity. How can such talk occur without there being input to the physical neurons *from the conscious mind?* How could the brain, acting on its own, have the information that certain of its neural states are associated with consciousness? To be sure, there are words such as 'stimulus' or 'knowledge' that might refer to data input and storage in the brain, but the word 'consciousness' means something different. We are able to have debates about when, how, why or whether *consciousness* occurs which do not make much sense if it is the other things that are being referred to. Moreover, the words that my brain formulates correspond with precision to my personal experience of consciousness. All this surely requires informative input to the brain from my consciousness, which is impossible if the latter were a mere epiphenomenon.

At a more general level, once the distinctive nature of consciousness is acknowledged, it sounds quite arbitrary to restrict *a priori* what its relationship to the physical world may be. To make a parallel, Newton's third law of force states that if A affects B, then B will affect A. This law underlies the interactive dynamics of all physical processes. It seems entirely artificial to suppose that in the brain-consciousness interaction, the effect is only one-way. Epiphenomenalism, in short, is a seriously unconvincing hypothesis.

The position of Descartes

Let us sum up so far. Although many aspects of mental processes have been passed over, enough has been said to conclude that the conscious mind is a phenomenon that cannot be incorporated into the materialist paradigm. A new paradigm is needed that will include the mind, and it will be useful to consider some earlier viewpoints. One common opinion has been that the human mind

20 cf. for example Foster, J. *op.cit*.[10]; Elitzur, A.E. in Hameroff, S.R., Kaszniak A.W. & Scott, A.C. (eds.) *Towards a Science of Consciousness; the First Tucson Discussion and Debates,* Cambridge, MA: MIT Press (1996).

is an entity in some sense 'residing' in the body. This view is especially associated with the seventeenth-century philosopher René Descartes.

Descartes' primary goal was to establish a method to allow him to construct a philosophical system without prior assumptions.[21] As is well known, he began with the statement, which he felt it was impossible to doubt, that he *thought*. Therefore he existed. This starting point led to a dualistic system in which mind and matter are two distinct entities, namely that which *thinks* and that which is *spatially extended*. The mind does not possess spatial qualities, neither does the body think. However, it is possible to exaggerate Descartes' dualism. He rejected the Platonic view of a human being as a spirit that makes use of the body. The rational soul in the body is not like a pilot directing a ship (as debated by Aristotle),[22] but is 'very closely linked to [my body] and so to speak so intermingled with it that I seem to compose one whole'.[23] In reply to a critic he stated:[24] 'I think I have neither proved too much in showing that mind can exist apart from the body nor too little in saying it is substantially united to the body.' Here his position was not so different from the medieval thinkers whom we discuss below. Unlike Aquinas, however, he insisted that the mind on its own is a 'complete thing'.

The nature of the mind-body union he declined to discuss. 'These are questions of which the most ignorant man might raise more in a quarter of an hour than the wisest could solve in a lifetime.'[25] He refused to worry about it. All kinds of objects have very diverse physical attributes (so-called 'accidents') that are attached to them. People find no trouble with this. Why then should a mind not also be attached to a body?

It may be that Descartes' position was not fully consistent. What does 'substantially' united mean? Nevertheless, the strong distinction he erected between 'mind' and 'body' has been criticised as giving the physical world too much independence. This allows science to exclude mind and mental things entirely from its consideration while claiming all-competence.[26] A reification of the mind, meanwhile, is anathema to many. Descartes identified himself personally with his mind, saying that he could imagine existing without a body but not without a mind. At the same time, he strove hard to take fully into account the laws of nature and the workings of the body, especially the brain and nervous system. This was quite an innovation at the time.

21 Descartes, R. *Discourse on the Method*. I refer here (EC) to the Wordsworth Classics edition of Descartes' works (1997) ed. E. Chávez-Arviso, trans. E. S. Haldane and G. R. T. Ross (first pub. Cambridge 1911), and (AT) to the standard French-Latin edition, cited therein.
22 Descartes, R. *Meditations*, (EC) p. 183, (AT) VI 59; Aristotle, *Of the Soul* 1, 1.
23 Descartes, R. *ibid.* 6, (EC) p.183, (AT) VII 81.
24 Descartes, R. *Objections and Replies*, (EC) p. 246, (AT) VII 228.
25 Descartes, R. *ibid*, (EC) p.248, (AT) IX.A 213.
26 cf. Habgood, J. *Being a Person*, London: Hodder and Stoughton (1998).

The medieval scholars

More clearly integrated world-views had earlier been presented by the medieval 'scholastic' philosophers.[27] Their basic standpoint was that any physical object comprises a union between a forming idea and matter. At the end of the Roman period, St Augustine had taught that every existing thing receives its form from God, and that without its form it would cease to be. In the thirteenth century, Thomas Aquinas took over this position, which integrates the Christian concept of God into the philosophy of Aristotle. Within God there exist as many forms, or ideas, as there are existing creatures, for which the divine ideas are 'exemplars'.[28] Ideas in the created order, however, exist only incorporated in material things. In contrast to this position, Plato[29] had taught that ideas exist independently of both creation and Creator. The slightly later medieval scholar John Duns Scotus took an intermediate view that ideas can exist on their own as created entities.[30] But in any case it is always the matter-form union that gives a physical thing its existence and identity, referred to as its 'essence'. The latter is not an esoteric inner quality of something, we note, but simply designates 'what it is'.[31]

Like others at the time, Aquinas was aware only of what we would call 'large-scale' objects. Thus he regarded every plant, rock, and human being individually, with its own given form. Although atomic theories of matter had existed in Greek times, Aquinas took little notice of them, making use instead of the commonly employed concept of 'primary matter' *(materia prima)* out of which all physical things are formed. He taught that primary matter cannot exist on its own, without being given form, except 'in potential'.[32] However, the medieval scholars were not in full consensus on this point.

St Augustine had considered the human body and soul to be separate things. The medieval scholars sought to unite the two, while also allowing the soul to be immortal. To do this they had to acknowledge that the soul (or intellect or mind) is not just a static form or idea implanted in matter, but is something active. Aquinas argued that the active aspect of the human soul must require a substantial agent – a thought requires something that thinks – even if the substance of this agent cannot be corporeal.[33] He ended up with complex souls that differ according to their possessors: the soul is merely an elementary

27 Information for these sections is drawn from Gilson, E. *The Spirit of Medieval Philosophy* (Charles Scribner's Sons, 1936; Univ. of Notre Dame Press, 1991), with the online *Stanford Encyclopedia of Philosophy*, Copleston, F. *A History of Philosophy*, Vol. 2, and original authors.
28 Aquinas, T. *Summa Theologica*, 1.15.3; note that the term 'idea' is Greek for the Latin 'form' and Aquinas uses the two words rather similarly.
29 Gilson, E. *op.cit.* [27], p. 157.
30 Gilson, E. *op.cit*. [27], p. 160.
31 See e.g. Aquinas, T. *Compendium of Theology*, ch. 11. Today's usage of the word, as in 'almond essence', is quite different from that of Aquinas!
32 Aquinas, T. *De Principiis Naturae*, ch. 2.
33 Aquinas, T. *Summa Theologica*, 1.75.2; 1.75.3.

'form' in inanimate things and plants, but in a human being it is a substantial and dynamical intellectual entity, at the same time retaining the function of providing bodily form. Duns Scotus argued for the presence of more than one soul in human beings: one to give form to the body ('embodied form') and also one to give life to it ('animate form').[34]

Can these medieval philosophies be adapted to a modern scientific worldview? Their virtue is that they present *a unified picture of all aspects of our natural existence*, including both physics and the human mind. A problem today with Aquinas' position is his requirement for all physical objects to be created individually by God, for we now find that elementary particles can come into being naturally during the course of physical processes. The uniformity of physics moreover requires the presence of *universal* principles within nature. It may be easiest therefore to adopt the Scotist view that ideas are created things in nature, and seek to apply this notion to the laws of physics.

Laws of Nature as ideas built into nature

Taking a realist view of the laws of nature, I argue that they can be regarded as 'formative ideas' built into the fabric of the universe, and determining the characteristics of physical things. This will be a first step towards a more integrated conception of nature. However, we must consider the ways in which the medieval and modern pictures differ.

Medieval thinking, we have noted, dealt exclusively with what we see now as 'large-scale' systems, while the modern view requires the relevant principles to act on the atomic scale. Even so, the microscopic action of laws has an effect that adds up to large-scale formational principles – for example, the physical 'form' of a crystal comes from its structure, with both this and the crystal's overall properties being consequences of the laws of physics. The observed form of a chicken has not been imposed template-like upon a selection of chemicals, as the medievals might have imagined. But through a process of historical development involving physical laws at all levels, the present species has come to be. Altogether, laws and 'forms' seem compatible notions.

A second point is that modern physicists are accustomed to thinking about space and time together. If forming principles act spatially, then it is logical to consider that they also act temporally, since space-time is a four-dimensional structure now. The persistence or change of spatial form over time may thus be regarded as 'temporal form'. It derives from the laws of nature, and physical conservation principles can be important. The spatial and temporal aspects of laws of nature are indeed not easily separable; Schrödinger's equation, for example, expresses the mathematical law that determines the structural form of an atom, and also its behaviour in time.

34 See Gilson, E. *op.cit.* [27], ch 9 for a more extended discussion.

Other equations apply to the elementary particles which make up atoms. Without such determining principles, the atoms and particles would not exist, and new particles would not come into being when conditions permit. The laws governing a rare kind of unstable particle seem to 'exist', moreover, even if no such particles happen to exist in the universe right now.

Thirdly, medieval teaching designated many attributes of objects as 'accidents': not part of the object's basic identity. In modern physics, however, *all* physical attributes of an object are law-determined or law-guided, and are part of its physical nature. But this does not present any obvious difficulties.

A qualification to all of this is that owing to quantum indeterminacy, physics at the atomic level is not completely law-governed. Nevertheless, the laws do establish definite probabilities for the various outcomes in a situation, and to this extent an atomic particle's temporal behaviour possesses form. The behaviour of a large-scale object is not normally sensitive to the small-scale randomnesses. It arises as the total effect of the law-like aspects of all its atoms' behaviour, while the effects of the randomness average out.

It needs to be noted that laws of nature are not the only factors affecting physical systems. Apart from quantum randomness we require a place for human free will. The laws of nature also act within constraints, such as the state of a system at a given initial time, and any spatial boundary conditions that may be present. These are consequences of systems being finite, and of their interacting with their surroundings.

Bearing the above in mind, there seems no reason why the laws which shape and direct the physical universe should not be considered as 'ideas', existing as part of the created order. We are thereby taking a position which the medievals would have termed 'universalist', and which is closer to Duns Scotus than to Aquinas. Such a mode of existence gives the laws autonomy to operate, and scientific questions can be distinguished from theological questions. An alternative position is to suggest that laws of nature exist quite literally as part of 'the Mind of God', rather than as created expressions of God's Mind. This position would be consistent with certain statements made by the cosmologist Stephen Hawking. Einstein probably held this kind of view, which implies that creation and Deity are not ontologically distinct.

Duns Scotus believed that ideas and 'primary matter' can both exist on their own. But what, today, is primary matter? This elusive concept has no place in the Copenhagen interpretation of quantum mechanics, but it may perhaps be applied to quantum fields. This will be discussed below.

The matter problem

There is a common agreement that we lack direct experience of matter. Light, sound and other effects originating from a physical object are received by our sense-organs, and the resulting data are mediated through the brain into a

conscious experience. However, the information we obtain always concerns the object's form, attributes and behaviour, and not its material substance – whatever that may be.

If this is our situation at the everyday level, then a difficulty in thinking about matter at the quantum level comes as indeed no surprise. Various physical concepts are available to us here, such as observables, measurements and wave-functions; but the quantum particle 'as such' is elusive. The ways of thinking that serve us usefully at the everyday level are less helpful now. At both levels, though, the notion of 'matter' must be considered as an abstraction from our experiences. In ordinary life we habitually and confidently make this abstraction; at the quantum level our imagination has trouble.

From the medieval philosophers back to Aristotle it was considered that primary matter is without describable characteristics. In the eighteenth century, Immanuel Kant distinguished between those phenomenal aspects of an object which are known through experience – ultimately sense-experience – and the so-called 'thing in itself' (Ding an sich) which is beyond the experiences, while being the origin of them. For Kant, the thing-in-itself was 'transcendent' and outside the scope of all physical language.[35] In fact the terminology he used is very reminiscent of that used by mystical theologians in referring to God through the *via negativa*,[36] and similar to Kant's own reference to God. What we have up to now been discussing as 'physical matter' is largely compatible with Kant's 'thing-in-itself'. In this connection, therefore, it must be clearly stated that I do not wish to imply that matter as such is mystical, or divine, or in any way 'deeper' than the associated phenomenal forms possessed by the physical objects around us.

Kant's view that the thing-in-itself is the origin (Ursache) of the appearances seems to point in the opposite direction to that of Aquinas, for whom form has causal primacy over matter.[37] Certain other thinkers, such as Eddington, as we shall see, have gone to the extreme of disowning matter altogether. For the medieval philosophers, however, central identity (essence) is always to be found in the union of form and matter,[38] and overall I would claim that modern physics, using the language of physical laws, is closer here to Aquinas and Duns Scotus than to Kant. There may be further parallels. According to Aquinas, matter exists 'in potential' until a form actualises it; particle physics uses the concept of 'virtual particles' which appear as real particles only if law-given physical processes actualise them.

35 Kant, I. *Critique of Pure Reason*, 1787 edn. p344f.
36 That is, one seeks to move towards God in meditation by rejecting all earthly forms, impressions, images and thoughts, which are considered to stand in the way of God, Who is beyond them all.
37 Aquinas, T. *Compendium Theologica,* ch. 71,
38 Aquinas, T. *On Being and Essence*, ch. 2.

Quantum fields – a candidate for primary matter?

The most basic elements of modern physics at present are quantum fields. These are physical quantities that are believed to exist everywhere in space. Being quantised, their values are not in general precisely determined; however, at different points in space and time they can show strong correlations in the form of mathematical patterns. The attributes of an elementary particle, such as its energy and momentum, are associated with certain types of quantum field pattern – given in these cases by the mathematics of sine waves. But the elementary particle itself is not material in a familiar way. When it 'moves', no 'thing' seems to move; it is rather that the same mathematical pattern just becomes established in the quantum fields in a new region of space. We may well ask, then: is matter now vanished, with only patterns remaining, like the lingering smile of a vanished Cheshire Cat? The answer is unclear. Traditionally, one had not thought of physical field quantities as 'material'. (Nor are energy and momentum normally considered as 'material', but rather as *attributes* of material things. There is no such thing as 'pure energy'.)

A case could be made for associating the materiality of a particle with its mass, and in fact the massive quarks which form most elementary particles are often called 'matter particles' while the massless photons and gluons are called 'force' particles. But even so, a photon is a particle, and it seems arbitrary to deny it substantiality, while forces can also be transmitted by massive particle fields. Although electromagnetic waves would not earlier have been termed 'material', perhaps a photon, as a quantised electromagnetic wave, now ought to be? Clearly there are some very subtle questions in this area.

In a recent review,[39] the theorist Frank Wilczek refers to quantum fields as 'ur-stuff': primary matter, in other words. No doubt they are currently our best candidate for this, despite the reservations mentioned above. Their apparent ability to exist on their own, without being excited into particles, is in accord with Duns Scotus' ideas. However, they do possess attributes such as energy, and physical laws apply to them; thus they do not constitute the featureless primary matter envisaged by the medieval scholars.

Perhaps our best definition of 'matter' for now is simply *that in which physical ideas are instantiated*, in agreement with the medieval thinkers without explicitly identifying primary matter. The 'idea' of an electron or photon – that is, those physical laws which determine how it can exist – is instantiated in each and every actual electron or photon.

Nature and the mind

Together with their universality, the laws of physics have a nature that is

39 Wilczek, F. *Rev. Mod. Phys.* (1999) 71, S85.

mathematical.[40] This should not be taken for granted or underplayed, since it seems to give a scientific indication that a rational principle underlies the universe. Let two of the developers of quantum theory speak, firstly Eugene Wigner:[41]

> The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve.

and Paul Dirac:[42]

> … fundamental physical laws are described in terms of a mathematical theory of great beauty and power…. One could perhaps describe the situation by saying that God is a mathematician of a very high order and He used very advanced mathematics in constructing the universe.

What is the nature of mathematics? Developments over the last century have thoroughly undermined the notion that the subject is simply a set of rules which human beings devise.[43] If we start with the work of Kurt Gödel, it has been realised, for example, that equations can exist where there are no solutions of a given kind, or a finite number, or an infinite number – but where we cannot demonstrate which is the case. Numbers – in fact, most numbers – can be 'random' in the sense that we cannot define them by any formula or calculational procedure. But the *existence* of all these numbers seems to be an essential part of mathematics, and there is little doubt that they can quantify physical processes and things. In other words, an objective 'mathematical reality' may be said to exist that is only partially accessible by our formal methods,[44] and is present within nature.

There is a strong tradition inherited from the Greek philosophers to associate mathematics and 'mathematical reality' with a category that can be thought of as 'mental'. Mathematical ideas have a universality not easily derivable from our finite experience, but they can be a part of our thinking and be expressed in human mathematical language. An identification of the laws of physics as 'mental' in nature fits in with this tradition. These laws are the ideas – the mathematical ideas – that form and direct the course of the physical universe.

40 This idea originated largely with Pythagoras. Aristotle and his medieval followers mainly ignored mathematics in nature since they equated it with geometry, something static. Newton made the breakthrough, revolutionising mathematics in the process, by mathematically accounting for the dynamics of motion, and in particular planetary motion. But Galileo, in his *Assayer,* had already written that 'the book of nature is written in the language of mathematics'.

41 Wigner, E.P. 'The Unreasonable Effectiveness of Mathematics in the Natural Sciences', *Commun. in Pure and App. Math*., XIII (1960) 1.

42 Dirac, P.A.M. *Scientific American*, May 1963, p. 45.

43 A relatively accessible overview is given in Casti J.L.& DePauli, W. *Gödel,* Cambridge, MA: Perseus (2001).

44 Of course there are other philosophies of mathematics, and the medieval Nominalist school would have rejected much of what is said here.

The twentieth-century astronomer Arthur Eddington made a much-quoted declaration that 'the stuff of the world is mind-stuff'.[45] The designation 'stuff' merely denotes a function 'as a basis of world-building', he stated: 'I certainly do not intend to materialise or substantialise mind.' His opinion in fact was to consider the entire notion of material substance as an 'illusion' – a very different viewpoint indeed from the medieval thinkers. I do not accept this aspect of his position, despite the fact that putting one's finger on material substance is nowadays especially difficult. Materiality is somehow real. With this important qualification Eddington's proposal seems to me convincing. There is a universal category of the mental. It is not to be equated simply with the human conscious mind, nor even with the extension of the latter to the subconscious. Rather, to quote Eddington again, 'beyond that we must postulate something indefinite but yet continuous with our mental nature'.

We might refer to this continuum as a 'mental dimension' to existence, taking both words in a broad sense. It provides the connecting principle for the ideas which comprise the laws of nature, for the contents of our own minds, and maybe for other things as well.[46] It is because our own minds can have intimate contact with 'ideas' that the term 'mental dimension' seems appropriate – although its existence is independent of our own minds.

Now if laws of nature act to shape the universe in space and in time, their own mode of existence might seem to lie in some sense outside space-time. Their spacelessness and timelessness give rise to the universality of their action in space and in time. Certainly, to the Greeks, mathematics in the form of geometry possessed a nature of 'eternal truth', which even inhibited Aristotle from applying mathematics to the changing temporal world. This topic requires a more extensive treatment than is possible here.

Human mental contents are more localised in space and in time, but still seem to have an existence that is sufficiently temporally extended to give stability to our personality and conscious experiences. The following point now emerges. The persistence in time of our personal nature has often been debated by philosophers, who have asked whether it is based on our psychological or on our corporeal nature, or on both.[47] It seems easiest to say on both. Now, if the natures of physical laws and human mental elements are related, then they may have a related role in providing temporal continuity for our personal existence. This gives a natural way to answer 'both' to the above-stated question.

But of course, any discussion of our mental nature must refer to our conscious sensations ('qualia'). It is interesting to note that these can often play

45 Eddington, A.S. *The Nature of the Physical World*, Cambridge: Cambridge University Press (1933), p.276ff.

46 A similar concept is termed the 'noetic world' by J. Polkinghorne. In Polkinghorne, J. *Science and Creation*, London: SPCK (1988) he develops a number of ideas about such a realm, with a special emphasis on mathematics.

47 For a recent review, see Olson, E. in Stich, S.& Warfield, F.(eds.) *op.cit.*[6].

the role of 'mental matter' in making ideas and forms into conscious mental objects – a red circle, for example, has its circularity 'embodied' in redness. However, human mental processes involve the physical brain concurrently with the conscious mind. The different qualia are known to be produced by activity in specific brain areas. Presumably some extended law of nature enables this; we now have no reason to disconnect 'mental' from 'physical' laws.

These briefly outlined themes, it seems to me, may point the way to progress the thinking of the medieval scholars into the present age. Laws of physics and contents of human minds are both 'mental' in nature. The former are universal in scope and common to all physical things, the latter are localised around individual human brains, but both take part in forming the latter's behaviour. They correspond to Duns Scotus' two types of 'soul', the 'embodied' and the 'animate'. The second of these comprises our own minds, whose interaction with the brain appears to be two-way and associated with consciousness. Could conscious qualia be regarded as energy-bearing 'mental fields'?

Minds and brains

The study of the conscious mind and its elaborate connection with the body involves the natural sciences, not just philosophy, and has become the subject of extensive research involving many perspectives and disciplines.[48] It is not possible to survey here in detail the many recent suggestions regarding the interaction between the conscious mind and the brain.[49] Many believe that conscious activity is distributed over the brain rather than occurring in a localised 'seat of the soul'. We do not know whether the mental interaction specifically involves quantum phenomena. If so, these might occur in the neural synapses,[50] inside the neuron structures known as microtubules,[51] or elsewhere. The sensitivity of neural function to quantum processes is however disputed. I refer the reader to the literature for details, because unfortunately none of the postulated physical mechanisms for consciousness has yet been in

48 Metzinger, T.(ed.) *Conscious Experience*, Paderborn: Imprint Academic and Schönigh, (1995); Hameroff, S.R., Kaszniak, A.W. & Scott, A.C. (eds.) *Towards a Science of Consciousness; the First Tucson Discussion and Debates,* Cambridge, MA: MIT Press (1996); *Towards a Science of Consciousness; the Second Tucson Discussion and Debates*, Cambridge, MA: MIT Press (1998); Hameroff, S.R., Kaszniak, A.W. & Chalmers, D.J. (eds.) *Towards a Science of Consciousness; the Third Tucson Discussion and Debates*, Cambridge, MA: MIT Press (1999); Århem, P., Liljenström, H. & Svedin, U. (eds.) *Matter Matters?*, Berlin and Heidelberg: Springer (1997); Bickle, J. in Stich, S.& Warfield, F.(eds.) [6].

49 Århem, P., Liljenström, H. & Svedin, U. (eds.) *op.cit.*[48] ; Bickle, J. in Stich, S.& Warfield, F. (eds.) [6]; Metzinger, T. (ed.) *Neural Correlates of Consciousness*, Cambridge, MA: MIT Press (2000).

50 Eccles, J.C. *Evolution of the Brain: Creation of the Self*, London: Routledge (1989); Popper, K.R. & Eccles, J.C. *The Self and its Brain*, Berlin and Heidelberg: Springer (1977).

51 Hameroff, S. in Århem, P., Liljenström, H.& Svedin, U. (eds.) *op.cit.*[48]; Hameroff, S.& Penrose, R. in Hameroff, S.R., Kaszniak, A.W. & Scott, A.C. (eds.) *Towards a Science of Consciousness; the First Tucson Discussion and Debates,* Cambridge, MA: MIT Press (1996), and references; Penrose, R. *The Emperor's New Mind*, Oxford: Oxford Univ. Press (1989).

any way established as likely. How the brain acts to make possible our subjective experience is at present 'a complete mystery'.[52] The interconnectivity of neurons is so complex that even the inhibition of their normal functioning by anaesthesia tells us little about the crucial nexus with consciousness. Without such information, of course, we are certainly in no sound position to speculate whether artificial systems can ever be conscious,[53] another contentious area.

The possibility exists that neuroscience may be incapable of elucidating consciousness. Let me extend the well-known story of the drunken man who looks for his lost keys beneath a lamp-post, since this is the only place he can hope to find them. Now suppose he fails to find his keys there – and concludes that he never had any keys after all! This could be the logic of those who fail to find the human mind in neuroscience experiments, and therefore conclude that there is no such thing as the human mind.

There is even a suggestion [54] that the interaction between consciousness and physical matter need have no rational explanation at all; it is just a basic fact of nature. Still, scenarios for this interaction should surely be researched to take our understanding as far as it can go. Theories of 'mental fields' affecting quantum amplitudes, strange as they may sound, should not for example be ruled out of court. The laws of physics act within nature, but additional factors may be allowed to act too.

Final remarks

The medieval philosophers were prolific in their output of metaphysical ideas because their Christian beliefs gave them a foundation to work from. Nevertheless, they distinguished between what is known by argument and what is known by faith. Today it is essential to integrate scientific knowledge into the discussion. This, with a combination of ideas from Aquinas, Duns Scotus and Eddington offers promise for a philosophy that may actually advance us beyond materialism in understanding human nature in the universe.

On this foundation, we have discussed some very basic issues in the area of mind and matter. It was argued that the place once occupied by forms, ideas, and 'souls' – in an inanimate sense – can be taken by the laws of nature. Standard materialism asserts that the latter displace *entirely* the traditional usage of the word 'soul'. But it is clear that one of the hardest questions consists of how or if at all – to understand *matter*.

The issue of how mind interacts with matter is addressed by following the well-trodden route that physical systems *intrinsically* comprise mind and matter. For this, the concept of 'mind' must be broadened to encompass those inan-

52 Crick, F. in Metzinger, T. (ed.) *op.cit.*[49].
53 cf. Århem, P. and Lindahl, B.I.B. in Eccles, J.C. *op.cit.*[50], and references.
54 Chalmers, D. *op.cit.*[9]; Foster, J. *op.cit.* [10]

imate principles – ideas now understood as 'laws of nature' – which are present as formative factors in determining the attributes and behaviour of all physically existing things. Aquinas attributed a special spiritual quality to the formative principle in human beings, but it seems better to follow Duns Scotus and Eddington here and allow for qualitatively different types of principle within a broad 'mental dimension' – one of which is to be associated with the human conscious mind. The interaction of mind with matter, then, is no longer something exotic: the whole universe operates on this basis! But only very tentative indications can be suggested at present concerning the why's and how's of a *conscious* aspect to the mind. Even without our understanding it, though, consciousness exists. A deep field of enquiry seems indicated extending beyond physics, but retaining a connection to physics. The hardest questions may now have been displaced to some area outside the capability of science to give the full answer, but I suggest that this is likely to prove a truer perspective.

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