Transcendence in physics: an oxymoron

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Transcendence versus physics

'Transcendence' and 'physics' seem to be incompatible terms: Physics researches the laws of nature in terms of what can be observed in repeatable and controllable experimental settings. In other words, it researches the world in as far as it is amenable to our grasping and, in principle, to our control. Transcendence concerns what goes beyond and is normally associated with what goes beyond our ability to understand or control (Hartshorne 1986:16; Stone 1992:13; 2003:785). It seems, therefore, that if transcendence is studied by physics, it would not be transcendent (and vice versa). Transcendence in physics would therefore be an oxymoron. Nature or reality, in as far as natural science perceives it, is the totality of those things that are reliably experientiable and subject to being couched in terms of natural laws; transcendence does not satisfy this condition (Gregersen 2005:548)

However, this is not quite so. In terms of Gödel's theorem, physics (like any science) can never be proven to be both complete and without contradiction. As physicists claim that physics is internally self-consistent, they cannot conclusively claim that it is complete – and therefore have to admit that what goes beyond their capacity to theoretically incorporate might exist. This is transcendent to them. (Rosser 2004:223ff)

This paper discusses four forms of transcendence in physics: (1) transcendence in physics, (2) transcendence of physics, (3) transcendence from physics and (4) transcendence beyond physics.

Transcendence in physics

The concept 'transcendence', in implying a going beyond, implies a boundary that is transcended. The definition of this boundary, in a sense, defines both the transcendent and what is transcended. Therefore, in its definition, for example as the study of processes that can be repeatably and reliably observed and reduced to natural laws, physics simultaneously defines what transcends it: processes and experiences that are not repeatable and cannot be reliably observed. (We will return to this later.)

However, even within physics, instances of transcendence (in a broad sense) occur: instances that indicate that the realm of all that is greater than the realm of that which is understood by physics. I will mention five that I regard as indicative of the state of the relationship between physics and transcendence.

Dark matter and energy

If we think of physical astronomy, we tend to think of the observation of stars and galaxies and associated objects. However, only 4.6% of the mass of the universe, as observed by physics, is composed of atoms – and less than half of this is compacted into stars. More than half of the atomic matter consists of the dispersed gas clouds in the intergalactic space. The vast preponderance of mass of this universe is composed of dark matter (approximately 23%) and dark energy (approximately 72%). In as far as all that we know of this dark matter or dark energy is that it exists, and that it influences gravitational effects in the large scale of the universe, it – at present – transcends our knowledge (Hinshaw 2010). The dark matter is variously, and whimsically, theorised to be composed of WIMPs, MACHOs, or RAMBOs[1]; however, at present, all of this is just theory and speculation.

Multiverse and hyper-inflational disconnected regions

Another instance of what might be termed "transcendence" in physics is similarly speculative. In order to explain the exquisite appropriateness of the parameters of the known universe to the requirements of life, various theoreticians postulate a multiverse (a multiplicity of universes in which the parameters vary randomly) and

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[1] Weakly interacting massive particles are elementary particles that are nearly, but not quite, without mass and interact only very weakly with other matter – the neutrino (if it has mass) or the neutralino (if it exists) would be candidates. Massive compact halo objects are objects that are similar to planets or burnt-out suns. They emit no radiation and because they are dense and yet scatter very little light, they are difficult to detect. The same applies, on a much smaller scale, to reliably associated massive baryonic objects. (Zuckerman & Malkan 1996:11f)

our universe (which is the one that we observe) is of course the one that has the right parameters for life. The other universes are, in principle, removed from our observation and are therefore transcendent to us (Tegmark 2003:50). Also from cosmological evolution comes the idea of hyperinflation – in terms of which, during the initial stages of the universe, some regions expanded so fast that they lost all contact with other regions (Heller 1995:112). The other regions are beyond our observation or manipulation – and are therefore transcendent.

Origin of the universe

One of the consequences of Big Bang cosmology is that our universe is temporally bounded in the past – the time that it existed is finite. Even if, as Hawking argues (Hawking 1998:146), there is a quantum-relativistic smooth boundary at the origin of the universe – similar to the earth being bounded without it having an edge that we can fall off – the very boundedness or finitude of the universe leads to the question of what gave rise to it (Isham 1993:52f; Russell 1993:296). If the answer is based on the laws of nature that we observe in the universe, the question arises whether these laws pre-exist our universe, and in what form they do so or what occasions these laws. This 'beyond', out of which the laws or the universe itself comes, can be seen as a transcendence that physics points towards.

Quantum uncertainty

The scale of physics, the ability of physics to investigate, is limited by quantum uncertainty. Phenomena that are smaller in scale than the Planck length and shorter in time than the Planck time go beyond the limit of being reliably observable, which is what the scientific method requires (Fagg 2003:561). In the realm of the very small, quantum physics tells us that events occur both in terms of determinative laws and because of chance. What does this mean? Clearly, the chance that is involved is something that cannot be controlled, or investigated, by physics – and therefore constitutes a form of transcendence. (More on this later.)

Complex systems

At the middle of the scale of physics, we also have phenomena that go beyond the control and prediction of physical theories. Theories of chaos and complexity deal with complex, co-operative entities, in which disturbances as small as the gravitational influence of an electron on the other edge of the galaxy can cause a system to develop differently. These systems are therefore in practice unpredictable – and what happens in them is therefore, for physical prediction, transcendent (Polkinghorne 1995:153; 2008:211f).

Transcendence, of course, is in a paradoxical binding to immanence. A transcendence that is totally beyond and utterly unrelated to any experience we can have – of which other universes in the multiverse are an example – is so far beyond us that it matters nothing to us: *quae supra nos, nihil ad nos* (what is above us, is nothing to us). In order for us to reflect meaningfully on a transcendent reality, it must in some way be connected to (and therefore have some embedding in) our experienced, immanent reality. In the relation between transcendence and physics, we are therefore searching for indications that an aspect of reality is such that while it impacts (and has effects in reality) it is not amenable to the modes of analysis that physics – or, by extension, natural science – engages in.

Transcendence of physics

Of course, stating that these areas of the results of physics are, at present, beyond the reach of physical theory, does not mean that they always will be beyond the understanding of physics. Indeed, the history of physics shows that it continuously expands its applicability in that it continuously converts that which had been formerly transcendent to it into that which is now immanent to it. This process of self-transcendence is the next relation between physics and transcendence that should be mentioned: the practice of physics involves transcendence in that it is always aimed at transcending the present state of knowledge in order to gain a deeper and wider understanding of the structure of the world.

This continuous self-transcendence can be seen in the history of physics. We can see it in how physics itself conceived of, and progressed in, its relation to transcendence. In the middle ages, using its version of Aristotelian physics, transcendence was conceived of spatially as the beyond of the sphere of fixed stars – and so was radically removed from immanence (Brooke 1991:84).

With the rise of the heliocentric model, and Newton's theory of gravitation and mechanical causation, the world itself expanded to infinity – and transcendence became much more difficult to conceive of. Yet Newton thought of an immanent transcendence, conceiving of infinite space as being the sensorium of God (Brooke 1991:137.145).

The confidence of physicists that their account would completely, and without reference to transcendence, account for the world as we know it, probably peaked in the eighteenth and nineteenth centuries. Laplace's famous dicta represents this: his assertion that he had no need of the hypothesis God and his claim that he could calculate all that was, is and will be, given the positions and the velocities of the particles in the universe. At the end of the nineteenth century, some physicists bemoaned the expectation that soon there would be no further discoveries to make – understanding gravity and the dynamics of material bodies through Newton's theory, the behaviour of electricity through Maxwell's theory, thermodynamics through the gas laws and chemistry through the periodic table, seemed to be the basis to understand every part of the mechanical, clockwork universe in all respects that mattered (Pannenberg 1991:54 & 55).

And yet, soon after, this state of affairs was transcended by the development of quantum theory, relativistic physics and the standard theory of elementary particles, together with the Big Bang model. In each of these cases, the initial simplicity of the model soon led to the realisation that the reality it described was significantly more complex than initially thought – and that further research was needed (Du Toit 2007:138).

Indeed, in spite of all the advances, physics still (and perhaps again with urgency) expects to transcend the present situation in order to account for what is seen as incomplete in the present theories – as evidenced by the examples mentioned.

Physics, throughout its history, always transcended itself. This is part of a more general characteristic of human beings in that they transcend boundaries of knowledge and constraints of behaviour, and as such studies about them properly fall under anthropology and human studies. The development in studies on human understanding and behaviour becoming wider in scope and more complex is, however, part of what seems to be a general characteristic of the universe. The results of physics show that the world is in a process of ever-increasing complexity, in which each stage of development is transcended by the next stage.

The initial undifferentiated energy of the Big Bang differentiates itself through subsequent symmetry breakings into a world in which four different elementary forces exist. Matter differentiates from energy and accumulates in structures that become galaxies; in stars hydrogen complexifies to higher elements, out of which planets (and in some cases biospheres, life and intelligence) arise (Heller 1995:112f; Zuckerman & Malkan 1996:15).

In each stage, the arising complexity transcends the previous – and with the new level of complexity, new forms of behaviour that are not totally predictable in terms of the analyses of the constituent parts arise (Peacocke 2008:133–135; Du Toit 2007:240). The behaviour of an organelle or a cell is not simply reducible to biochemistry; a body, while a collective of cells, needs an own paradigm to be understood; and the mind needs different categories to be understood than a single neuron.

This is possible, despite the third law of thermodynamics, due to the expansion of the universe. However, the kind of increasingly intricate structures that are developing indicate that the world is poised on a fine border between complexification and dissolution, which is often referred to as the edge of chaos.[2] In this sense, physics indicates that self-transcendence is embedded in the structure of the universe – and therefore that the urge to transcendence is immanent in our reality.

While this characteristic of physics points in this direction, to state that physics proves transcendence of any kind is misleading. Because investigation in physics is directed to the analytical and repeatable, the complex structures that originate in this process – such as the human brain – cannot be totally grasped by the method that constrains physics. Each higher level of complexity, in so far as it creates internal coherence or a Gestalt, has to be explained in terms of laws that are appropriate to its level – and so the higher-level explanations transcend the lower-level laws (Gregersen 2005:548; Peacocke 1995:284). This implies that higher-order structures are indeed a necessary part of the full description of complex systems – of which the human brain, and therefore the human mind and societies, is the most complex (Haught 2003:775). Indeed, the nature of the discipline of physics is transcended by the history of the universe: physics can but investigate the grammar of the language in which the story of this world is told**;** the meaning of the novel transcends the

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[2] The edge of chaos is defined as that realm – conceived of as narrow – in which the rules that govern a system are such that the system evolves neither into total random dissolution nor into static frigidity, but into complex (and complexifying) long-term behaviour (Miller & Scott 2007:129f, Gutowitz & Langton 1995:52f).

mode of inquiry that physics follows (Heller 1995:121; Tönsing 2009:153; Pannenberg 1991:37).

Transcendence beyond physics

The results of physics indicate that its analysis of causation is incomplete: it cannot fully understand the reasons why things happen the way they do. The net of causation that physics covers reality with is not totally dense – there are infinitely many, albeit infinitely small, intervals in this net. This is true in terms of quantum uncertainty, chaotic systems and the top-down causation of complex systems.

Quantum uncertainty occurs through the collapse of the wave function in measurement processes, where the outcome of the collapse is stochastic. This implies that the final state is not uniquely determined by all the knowledge physics that can access. Whether this is interpreted (in terms of the standard interpretation) as pure chance or as a hidden variable, the consequence still is that the knowledge that physicists have is not sufficient to uniquely determine the outcome of the event (Shimony 2001:5 & 6). This means that in the causal net that physics lays over reality, an opening for something beyond the knowledge of physics exists (Brooke 1991:327).

One can argue that a similar opening exists in terms of complex co-operative systems that exhibit sensitive dependence on initial or boundary conditions. These systems are often called chaotic systems. The argument would be that physicists can, because of the great sensitivity of such systems, never know exactly what the initial conditions or the boundary conditions are – and small changes, which in practice are unknowable to physicists (such as movements of electrons on the other edge of the galaxy or the flapping of a butterfly's wings on the shore of West Africa) can cause different behaviour in the system (Wildman & Russell 1995:81). Therefore, a total account of causality of such a system is beyond physics; it is transcendent to physics in the sense that while the results of the behaviour of such a system can have a real – even dramatic – impact on the lives of people, the prediction or manipulation of the system is beyond physics.

Understanding the world transcends what physics can achieve, but physics shows that transcendence is embedded in the structure of what is.

A simile can be taken from the realm of mathematics, where the term "transcendental numbers" indicates a subset of all numbers. They are what are left over after all algebraic numbers (numbers that are the solution of a polynomial equation with integer coefficients, such as $x^2–2=0$) are accounted for. In mathematical parlance, the set of algebraic numbers is countably infinite and dense, while the transcendental numbers are uncountably finite and dense. In-between any two algebraic numbers, which can be infinitely close to each other, is an infinite number of transcendental numbers (Baker 1990:1.3). This is easy to see: A transcendental number that is easy to construct is the number z=0.101001000100001 ... Given any two algebraic numbers x and y, one can take the difference and round it to one significant digit. If this is called t, multiply it with 0.1*z, 0.2*z ... and then 0.101*z, 0.202*z … and add to x. This set of numbers is uncountably infinite, and lie between x and y.

It seems to me that the human capacity to understand reality in terms of physics, to find an equation that governs a specific configuration of reality, can be likened to the set of algebraic numbers. Indeed, I suspect that a consistent set-theoretical argument can be made that the set space of physics – the account of all particles of the universe (an integer), their measured properties (again an integer number) and all laws (again an integer number) – is countably infinite. However, it can be surmised that the totality of possible states of the universe is uncountably infinite. We can achieve greater and greater understanding, so that our understanding appears dense over reality – but our understanding will, even though it comes close to reality, always be interpenetrated by an infinity of what we do not know.

What is beyond the grasp of physics will probably, like the transcendental numbers, remain greater than what is encompassed in our equations – just like there are uncountably infinitely more transcendental numbers than algebraic ones. Reality probably will always be more complex than physics can describe (Du Toit 2007:153). However, physics seems to indicate or hint that there is indeed something more than it can grasp – and physics can give us no indication of what this is or how it operates because it goes beyond what is accessible to the method of physics.

Theological interpretation

A theological interpretation of this could be that physics points to the hiddenness of God, but also shows that human reason is fundamentally unable to lift the veil that God has set on his activity.

This has implications for our attempts to understand God on the basis of experience. Can we, on the basis of what we experience, come to an understanding – even an appreciation – of the transcendent (Stone 2003:791)? Can physics form the basis for metaphysics (Fagg 2003:570)? Certainly, as argued above, physics hints toward something "more" than what is available to its method.

But if this "more" (the transcendent) is fundamentally unavailable to the scientific method, can this method derive conclusions about the transcendent?

In theology, Aquinas attempted a route from the limitations of experience to conclude toward the existence of the transcendent – his famous five proofs of God (Aquinas, ST Part I Q 2). Calvin asserted that the "knowledge of God is conspicuous in the creation, and continual government of the world" (Calvin, Institutes, Ch. 5) and that this knowledge is accessible, even though impressed upon, an impartial human mind. For both, the transcendent evidences itself in the apprehensible in a way that can be apprehended and therefore human rationality can draw conclusions about the transcendent on the basis of what it can grasp about the world.

Luther (1999, on Gen 1:3) asserted: "Whatever else belongs essentially to the Divinity cannot be grasped and understood, such as being outside time, before the world, etc … This nature of ours has become so misshapen through sin, so depraved and utterly corrupted, that it cannot recognize God or comprehend His nature without a covering." In this, Luther is followed by Barth (Du Toit 2007:195). The fundamental hiddenness of God to human attempts to discern him is not penetrable through human effort.

Our reflections on physics and transcendence leads to the conclusion that although physics points to that which is beyond itself, it cannot (for the very reason that this remains transcendent to it) give indications of the nature or working of that which is transcendent. This supports Luther's, rather than Calvin's or Aquinas', approach to the God–World relationship – though nature points beyond itself to transcendence, the nature of transcendence remains hidden to inquiry that is simply based on nature. Transcendence has to disclose itself to us in ways that are different from our apprehending inquiry.

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