The Elusive Universe

Is modern physics a branch of cultural anthropology?

By Joseph E. Green

The progress of science is strewn, like an ancient desert trail, with the bleached skeletons of discarded theories which once seemed to possess eternal life. –Arthur Koestler

The poet e. e. cummings once advised us "there's a hell of a good universe next door – let's go," and our modern cosmogony agrees with him. Far beyond the fables of old, we are told of a wondrous expanse of black holes, dark matter, brown dwarfs, and red shifts. Space, as befits the name, is mostly empty; indeed, even our own selves consist in large part of nothing. However, it turns out that what is there proves to be elusive and even metaphysical. Unlike the schematic models pre-Galileo, the current universe is depicted as a chaotic swirl, full of strangeness and not a little charm.

Science behaves in an orderly procession of logical building blocks and repeatable results. But unlike other scientific endeavors, theoretical physics has been weak in the area of what Karl Popper called "crucial experiments." It could also be said to be largely devoid of any experiments at all. This is because current theories of any explanatory power, including so-called String theory, have most of their effects on dimensions of reality unnoticed by ordinary mortals. I choose my words carefully here, for I wish to propose two hypotheses about theoretical physics as it is currently practiced: (1) there is no reason whatsoever to suppose it is true, and (2) it may be driven by anthropological forces which have their roots in ancient humanity.

AS SEEN ON TV

Columbia physics professor Brian Greene, author of Pulitzer-nominated book *The Elegant Universe,* had three hours granted to him by NOVA and PBS to explain string theory to the educated masses. And why not – an affable, good-looking Rhodes Scholar, with his undergraduate degree at Harvard and his graduate degree from Oxford, he's the perfect guy to do it. And with all the allegorical power he can muster, backed by a substantial budget for this sort of thing, he gave it the old college try.

Alas, one encounters many problems in trying to elucidate this material, and it shows in the numerous interviews included in the show. The physicists (several luminaries appear, including Steven Weinberg) admit, with notable chagrin, the difficulties involved in explaining situations and events which none of us will ever experience.

We have a picture of the universe that contains two separate explanations of physics: one that works for the very small (quantum mechanics) and one that works for the larger objects of everyday life (Newtonian physics, later modified – or undermined – through Relativity). These explanations invoke, in varying ways, the four known interactions of gravity, electromagnetism, the strong nuclear force, and the weak nuclear force. As pointed out in the program and Greene's book, the latter three can be understood using the same applied mathematics. However, the mathematics underlying gravity is different, and has resisted attempts to assimilate it into the other. The desire to resolve the three latter

forces into one single interaction is known as Grand Unified Theory; further, the integration of all four forces would give us the Theory of Everything (TOE), the Holy Grail of theoretical physics.

ARE NUMBERS 'REAL'?

Karl Popper, the great philosopher of science, once wrote that "Every 'good' scientific theory is a prohibition: it forbids certain things to happen. The more a theory forbids, the better it is."[1] By its very nature, a Theory of Everything has an inclusive tendency.

Mathematics drives the search for the TOE and one can see, at a glance, how this generates the language used to describe the universe. We have the black hole, whose center contains a gravitational singularity – that is, a point where the curvature of space-time becomes infinite. Due to the nature of black holes, they cannot be seen or identified, since they absorb everything, even light. Stephen Hawking became famous for identifying "Hawking Radiation" – radiation emitted by black holes – but the radiation is to this day only hypothetical. We also have The Big Bang, in which the universe is said to have begun. The Big Bang is itself a singularity, which means that all physical laws break down, and literally *anything can happen*. As a theory, it also fails to account for itself, having nothing whatever to say about the actual point at which time begins. If all physical laws break down, then of course it would be difficult to say how things actually got kicked off, so to speak.[2]

Now all these strange concepts and symbols occur because the physicist has to translate entities in the language of mathematics into word-based languages to make them sensible. And it has been asserted that some physicists, perhaps even most, hold the idea that mathematics has a kind of reality in itself. Math is not invented but discovered, having an existence in a Platonic idealized form.[3] This has difficulties in itself, as Roger Penrose notes:

> Some people have difficulties with accepting Plato's mathematical world as being in any sense 'real,' and would gain no comfort from a view that physical reality itself is merely constructed from abstract notions. My own position on this matter is that we should certainly take Plato's world as providing a kind of 'reality' to mathematical notions…but I might baulk at actually attempting to *identify* physical reality with the abstract reality of Plato's world.[4]

As well he should! But note the imprecision here. What is it, precisely, that we are asserting when we say that mathematics has an independent existence in an idealized state? And why would a physicist want to hold such an idea?

This leads us into somewhat complex waters, as we must discuss analytic and synthetic judgments, as well as *a priori* and *a posteriori* reasoning. Analytic statements are statements whose truth value is contained in the statement itself; i.e., tautologies. An example is "all black swans are black." If no swans ever existed, this statement would still be true. Synthetic judgment s are those which do not have their truth value contained in their expression, meaning most of the ordinary statements made in our daily existence. Now *a priori* means "before experience" and refers to things that can be identified as true without any experiential data; i.e., "2 + 2 = 4" or the same black swan example previously given. *A posteriori* means "after experience" and refers to any statement of reasoning about the natural world, such as "Water is composed of H2O."

Although 2 + 2 = 4 traditionally was included as an analytic proposition, the philosopher Immanuel Kant famously disagreed in his *Critique of Pure Reason* (1781), where he stated that mathematical statements were synthetic *a priori.* We can see that if mathematics is synthetic, then it is discovered to be an actual part of the natural world and not simply a self-contained data set. This is important for physicists because if this is so, then one really can chase God with numbers. Otherwise, one would be stuck in a situation where one could build enormous edifices of mathematics but never have a reason to think one is actually saying something about the real world.

Is there a reason to think that Kant was wrong?

The perfect example of this is the concept of dark matter. Greene relates that Vera Rubin, an astronomer, noted that according to the forces involved, galaxies should periodically be expelling stars like so many big-league fastballs. This does not happen. Ruben and her colleagues did not therefore conclude that there is something wrong with the theory of gravity. They instead invented – or discovered, if you like – "*dark matter* – matter that does not clump together in stars and hence does not give off light, and thus exerts a gravitational pull without revealing itself visibly."[5]

Because gravitational equations have many inherent problems that undermine their predictive ability, Albert Einstein had introduced a "cosmological constant" to try and fix them. This was widely regarded as an error at the time, but the idea has gained traction recently, and Greene even claims that the cosmological constant has been "confirmed experimentally." [6]

A stunning piece of reasoning follows this declaration in Greene's book, and we should look at it closely for a moment. He is discussing supernovae, and explains that researchers were able to make their equations work if observable physical matter only constitutes about five percent of the universe's mass. "A cosmological constant that contributes 70 percent of the critical density would, together with the 30 percent coming from ordinary matter and dark matter, bring the total mass/energy of the universe right up to the full 100 percent predicted by inflationary cosmology!...The supernova measurements and inflationary cosmology are wonderfully complementary. They confirm each other. Each provides a corroborating second opinion for the other."[7]

One *supposition* supports the other. On its face, this appears to be a spectacular bit of *ad hoc* reasoning. You may feel I am being unfair here; after all, this is a popular work designed for popular consumption, and cannot be held to same exacting standards as other disciplines. If we visit the science and mathematics underlying Greene's reasoning, we will find ample support for these conjectures.

Perhaps. I am going to leave this on one side for a moment. These metaphysical problems infect not just dark matter, but even the Big Bang and gravity itself. I will let Roger Penrose speak on these matters:

"Gravity seems to have a very special status, different from that of any other field."[8] The Big Bang, he writes elsewhere, "…was extraordinarily special, and we have learned something important about the nature of this specialness."[9]

Now it should be a problem to continually find "special" elements in any model. It is precisely at these points at which science (correctly) attacks such theories as Creationism or the efficacy of the rain dance. If we find that our theory of gravity is irreconcilable with our models of the various other forces, and that *all theories of any kind break down at the initial starting point of the universe* and that an invisible,

ineffable dark "stuff" covers the universe like an unending string of negative numbers, then what are we really saying?

String theory, which is hailed as a savior to the problems reconciling quantum mechanics with Newtonian physics, requires 10 or 11 dimensions. Aristotle's theory of the "unmoved mover" supports 1 or 55 unmoved movers. Are these assertions really so different from each other?

In reference to String theory, author Greene comes to our rescue:

> Now comes a leap…I certainly can't visualize this and I've never met anyone who can. But its meaning is clear. To specify the spatial location of a Planck-sized worm in such a universe requires nine pieces of information: three to locate its position in the usual extended dimensions tacked on to that point. When time is also taken into account, this is a ten-spacetime-dimensional universe, as required by the equations of string theory. If the extra six dimensions are curled up small enough, they would have easily escaped detection.[10]

Well certainly that is true. Even if an extra dimension were as large, say as an average Cavalier King Charles Spaniel, it could easily be stored out of sight in a handbag.

BUT THIS ISN'T PHILOSOPHY

Now I don't want to give anyone the wrong idea. I am not suggesting that what physicists are doing is a kind of philosophy. There is a great difference between what physicists do and the work of philosophers. Physics is based on mathematics.

As we were discussing earlier, all of this science is essentially founded on mathematics. Penrose again:

> This confidence – perhaps misplaced – must rest (although this fact is not often recognized) on the logical elegance, consistency, and mathematical power of the real number system, together with a belief in the profound mathematical harmony of Nature.[11]

Okay. So we understand that there is a sort of (dangerously mystical-sounding) harmony underlying this reasoning. The question then becomes: Are we justified in supposing that mathematical formulae, however detailed, have any correlation with independent reality? And if cannot adduce any real-world evidence that our equations do, in fact, describe something out there, do we have any right to call it a science? (And further: What constitutes evidence? Anyone who studies the matter realizes that determining when to scrap a theory and when to perform reconstructive surgery on it is enormously subjective. The theory of gravity has been essentially *falsified,* more than once.)

No one thought of the sun as a nuclear fireball until we understood the enormous destructive potential of nuclear energy. This is to say that new discoveries prompt new understandings, but also new metaphors. Discernment is a tricky business.

So does [mathematics] evoke, describe, or perhaps invoke [independent reality]? Are we describing the mind of God (in Einstein's sense) or are we merely ascribing a beast into existence because somebody divided by zero, where in another time they might have said that a living being fell from Zeus's hair?

BEGINNINGS

In the Stanley Kubrick/Steven Spielberg hybrid film *A.I.,* machines created by humans return to Earth, long after cataclysmic flood and another ice age have buried us all, on an archeological expedition. If, many thousands of years from now, such explorers found a book describing modern theoretical physics, what might they think about us? Would they say we had a religion in which we believed numbers could call into existence mighty entities, more powerful than any other object in the universe, from which no force could ever resist if it called for you? Would the Event Horizon of a Black Hole be thought of as a gateway to Hades? Would their psychologists wax speculative as to the possible underlying motives for our 'primitive' and seemingly fearful notions?

For someone attuned to the anthropological origins of religious belief, some of the language used in modern physics has an eerily familiar ring. Some of these are historical stories and some cutting-edge physics, but in any case there are evocations ripe for analysis.

In symbolic terms, one could break down Isaac Newton's discovery of gravity like so:

Apple
Fall
Tree
Knowledge

Rearrange these concepts a bit, and you have the story of a much older revolutionary event:

Tree
Knowledge
Apple
Fall

Eat, or so the Serpent instructed. And maybe it's all accidental but also maybe it's the unconscious replication of a meme that has been with us since we developed consciousness, an event which Julian Jaynes described as having been birthed from trauma.

Does String theory derive from mankind's seeming obsession with the Serpent that appears in the Ourobouros (the snake eating its own tail), the Bible story, in the Epic of Gilgamesh, in the countless legends of dragons around the globe? Ridiculous. But then I hear the physicists themselves speak of a vibrational pattern – a music of the spheres, if you will – generated by these serpents/strings that reverberates throughout the universe and even into our soulless selves.

This might all seem like analogies run amuck or poetic musings of the worst kind – but it also might serve as a warning that science has wandered far afield in pursuit of universal truths. I understand the impulse – I share that Faustian drive to Understand It All – but one is always toying with madness in such endeavors. It may be that reality is forever inaccessible to rationality (Hume and Kant thought so, for

very different reasons) while the only truth that one can truly own is intuitive in nature. In this regrettable event, we are using mathematics where others might have used totem animals or natural objects to represent the picture of the day. It would mean that all understandings are really metaphors, and that modern physics is a branch of imaginative literature. If true, this would not be so surprising. If history has taught us anything, it is that we perpetually look into the reflecting pool, see ourselves reflected back, and fall in love.

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[1] Popper, Karl, "Science: Conjectures and Refutations," Janet Kourany, ed. *Scientific Knowledge* (Wadsworth, Inc.: Belmont CA 1987), 141.
[2] Greene, Brian R. *The Fabric of the Cosmos* (Vintage Books: NY 2005), 272. Also see Stephen Hawking's *A Brief History of Time*, which discusses this in detail.
[3] See the *Phaedo*, 109a-111c.
[4] Penrose, Roger. *The Road to Reality* (Vintage Books: NY 2004), 1029.
[5] Greene, 295.
[6] Ibid, 300.
[7] Ibid, 300-301.
[8] Penrose, Roger, *The Road to Reality,* 731.
[9] Ibid, 731.
[10] Greene, 368.
[11] Penrose, Roger R. *The Emperor's New Mind* (University of Oxford Press: UK 1989), 87.