New Physics For Old

A Gentle Journey Through Modern Physics and Cosmology

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Abstract:
Our understanding of the Universe and our place in it has remained stagnant for around 70 years. Suddenly, a burst of new ideas has presented us with the real possibility of answers to the biggest questions of humankind. By adopting new physics we can let the cat out of old Schrödinger's box and finally solve the paradox once and for all. In this article, using language intended for non-scientists, the author first examines the problems with the old physics and cosmology. He follows up with reports of exciting developments being made by our greatest minds towards a new theory of the Universe.

PART 1 - So What Really Is The Answer To The Question of Life, The Universe, Everything?

These words have become a cliché and we hate clichés, don't we? Let's just call it *The Big Question*. Of course, we all know the answer. I could make life easy for myself and just write 42, but that would be a cop out, and in any case I want to try to explain things that have puzzled me as I contemplate that question once fictionally posed to a computer of the future by Douglas Adams in 1979.[1]

Some readers might proclaim that the answer should be God. I want to explain from the outset that I do not intend to promote the denial of God. I have always tended to be agnostic on the basis that there is no proof either way. If anything, traditional science tends to support atheism, even whilst - as we will read below - there are great flaws in science. As I write this, I am greatly excited by my recently found, life-changing pathway, and I am inclined towards a theist platform, but that is another story. It is enough here to say that the more I explore the mysteries of Life, the Universe and Everything, the more I am persuaded that some immense, unimaginable power is the actual answer - and not 42 - or even 14, for that matter.

Let's start with an easy one. What is life? This is a puzzle that has beset humans since they were able to contemplate themselves. We still have no precise answer, although science has enabled us to understand many of the principles that underpin the mystery. Life is no longer as mysterious as it once was. In 2008, medical researchers were able to create heart tissue from stem cells that began beating itself in a petri dish.[2] This would never have been thought possible, for isn't this the first sign of the life force? Done in a lab? Whatever next!

In fact, it is not really surprising to me, a chemist, who knows about the ways molecules are constantly in motion and how, even large molecules can change shape spontaneously. The atheist would smile at this point as he ticked off another reason why God was not involved in the creation of life.

But there are still many unanswered questions. One that focuses arguments quite well is this:

> *Are living things simply machines, built of atoms and molecules and programmed in some way as to carry out a set of procedures that allow them to self-replicate?*

There is a body of humanity that believes we are, but I think most of us would immediately answer No. I don't think that any human would use that description of themselves. Today, it is straightforward to build robots that mimic us, but how do we program feelings, awareness, intelligence?[3] We are conscious creatures

1 Adams, Douglas: The Hitch-hiker's Guide to the Galaxy, Pan Books (1979). Leaving aside the fictional computer, there are some people actually claiming to know the answer. Eric Weinstein says it is 14! Readers - please don't laugh. This is a serious essay. I am most certainly not poking fun at Weinstein who has proposed a very carefully crafted theory of - you know... His theory is called Geometric Unity, proposed in 2021. He needs 14 parameters for his model that covers everything in the Universe.

2 Beating Heart Tissue Grown In Lab. https://www.nature.com/articles/news.2008.775

3 Many people think that we are about to create intelligent machines with the new generations of AI. Apart from giving a

who have started to leave the planet on which we were created. How can we be merely machines?

But then, what about a tree? Or a fruit fly? Or a whale? What makes them different from each other and from us? All have evolved, just like us, yet there are enormous differences between us. I want to explore some of the ideas that are starting to emerge from recent advances in thinking by some of the world's best (human) brains. Inevitably it will take us on a deep journey into the very heart of physics and our understanding of the Universe.

(And if you hear any funny noises, it's probably Douglas Adams turning in his grave.)

The Big Question

You may not be aware that we are now on the verge of finding the answer to Douglas Adams' *Big Question* - one that has puzzled humans since our earliest days. What exactly is this Universe, how does it work and is there a God? If we knew all that, we would know the answer to how we come to be here. We might even be able finally to say that there is - indeed - a God.

These are the greatest questions of all. Many of us rely upon faith to support us through our lives. Faith works, but for those people who choose to study science, doubt soon takes its place. If the doubt persists then we call ourselves agnostic. If we take it to its obvious conclusion then we become disbelievers or atheists.[4]

Most of us scientists have given up all hope of ever knowing the answers simply because it is felt to be too hard or unknowable. I want to tell you that ideas have now emerged that finally give us a solid path to answering them. For me, at least, it has been life-changing. It ought to be a source of awe for all of us, for it gives us - for the first time in the history of our planet - a chance to understand how we come to be here. Yes, really!

Since I chose the path of science over sixty years ago I have been churning *The Big Question* over and over in my mind. I never expected to find the answer by myself, but in this golden age of science I had hoped that someone else might tell me what it is. I have followed my own path of enquiry with no-one to teach me. I have always read the popular science books, sometimes in awe, other times with incredulity and occasionally with ridicule, always hoping to find the answer. The finest brains in the world from Aristotle to Galileo to Newton and Einstein had been wrestling with the *The Big Question* for centuries. Einstein was fortunate in being able to make his major breakthroughs early in his career. Once that was done, he spent the rest of his life searching for the answer to his own version of *The Big Question* but failed to find it. Indeed, we now know that it was in these times simply not possible to resolve the issues for it turns out that we needed the computer to give us the tools we need. We also needed the new genius of Stephen Wolfram, a name that I expect to sit alongside Einstein in the history books of the future.[5]

It simply isn't sensible to dive straight into this wonderful news story which, without context, would leave many readers dazed or asleep. So, before we get deep into the philosophy of life, the Universe... well, you know, we need to consider the more general picture of what has been happening in science since the main building blocks were established.

The Old Physics:

What We Have Learned So Far And What We Still Don't Know. (A VERY Brief Survey!)

Science emerged from philosophy - the kind of thinking that took place when humans started to wonder about the world around them. Plato and Aristotle were early Greek philosophers who lived in pre-Christian times and who, we might say, set the ball rolling, as it were.[6]

machine access to the Internet for its knowledge and a good language interpreter, many of us find it doubtful that real human-like intelligence will be created for some time to come.

4 Heathen, pagan, or infidel could be used instead, but let's not get too personal.

5 Stephen Wolfram was born in London in 1959, but soon moved to California where he worked as a theoretical physicist with Richard Feynman. He soon spotted the potential for computational methods in physics and went on in 2005 to describe what he calls a New Kind of Science. He invented a new high level computer language and with a raft of new tools has - from around 2020 - developed an approach to modelling the Universe that will be discussed here.

6 There were obviously many deep thinkers before that, but unfortunately they remain anonymous to history.

As that philosophy developed it began to divide into different disciplines. The material world became part of chemistry and physics; the living world part of biology. The heavenly world came to be called astronomy and later cosmology. Things were measured. This was a crucial step. It set up a methodology in which practitioners devised a theory, predicted what would happen in a system and then measured what actually happened. This was a vital component of what then became known generally as science, with the language of mathematics at its root. Gradually, it was realised that there was overlap between these disciplines and that all science was underpinned by physics using the language of mathematics. This framework for scientific study was developed much more deeply in the early part of the 20th century, and, with a few other milestones along the way, it became the model for our understanding of life, the Uni… er, sorry.

Mathematics

Since those early Greek times, two thousand years ago, mathematics has been regarded as some kind of truth machine. The principle is that you put some numbers into an equation, and if the answer comes out right, that is, in accordance with some measurements you made, then your proposition is true and you'd better believe it.

The truth machine was thought to be infallible until 1931 when the Austrian logician Kurt Gödel showed that it was not.[7] Even so, physicists were not dismayed and have continued to apply their truth machine to all of their work. They expect all others to do the same. If a new theory does not conform to rigorous mathematical analysis then they are generally not interested. I raise this issue early in this essay because it has a huge bearing on what will come later.

The Newtonian paradigm

Probably the greatest British scientist of pre-modern times was Sir Isaac Newton (1642-1726). He established a way of understanding the Universe that prevailed for the next 200 years[8] and which, besides developing the powerful tools of mathematics, gave us the power to predict many things in nature, like the motions of the planets, laws of earthbound motion and interactions of solids with forces. Many a schoolchild has been made to wrestle with his equations and laws in their early years under the headings of statics and dynamics. Balls thrown into the air and ladders placed against walls were grist to the mills. Fortunately, not many of us were asked to plan a trajectory to Venus (except perhaps in the playground after school.)

An understanding of gravity was one of his greatest achievements and - if rockets had been available - local space travel using his equations could probably have worked, albeit with the occasional unanticipated flyby. By the late nineteenth century, there were signs that, powerful though Newton's methods were, there were limitations also. His equations were not accurate enough to work in some celestial circumstances.

Now, in traditional physics, when something works quite well, but isn't quite good enough, physicists fiddle about with their equations, add or subtract one or two new parameters, or add new particles.[9] Only very rarely do they dispense with a theory entirely and devise another. This turned out to be a case in point.

Albert Einstein

In modern times, Albert Einstein is probably considered to have been the greatest scientific mind because of several enormous contributions.[10] Studies of light during the nineteenth century had begun to show that light could behave both like continuous waves, but also like discrete particles. Einstein was able to prove that this strange behaviour was indeed real. The **Quantum Theory** was

7 Gödel's Incompleteness Theorems (1931) https://en.wikipedia.org/wiki/Gödel%27s_incompleteness_theorems

8 Thomas Kuhn (1922-1996) was an American historian and philosopher of science whose 1962 book The Structure of Scientific Revolutions was highly influential. He proposed that scientific fields undergo periodic "paradigm shifts" rather than solely progressing in a linear and continuous way.

9 I am indebted to Professor Neil Turok and Dr Sabine Hossenfelder for their delightful humour on this subject. Dr Hossenfelder publishes a popular YouTube channel called Science Without The Gobbledegook in which she uses her deep knowledge, insight and a relaxed presentation style to clear away speculation and mis-truths from science and technology.

10 Einstein made a big contribution with his work on the photoelectric effect, which showed how atoms had quantum behaviour. He also explained Brownian motion and developed Special Relativity which deals with time dilation.

born[11] and opened the door to the remarkable explorations of the 20th century that have led to the construction of the Large Hadron Collider at CERN on the French/Swiss border that is operational well into the 21st century. All of this work has added countless pieces of the world's most difficult (and expensive[12]) jigsaw that have come together into the **Standard Model of Particle Physics**.

Perhaps his biggest impact was made in 1915 when he was able to iron out all of the flaws in Newton's laws of gravity and to devise what many regard as an almost perfect gravitational theory which is simply called **General Relativity Theory**. There now existed the tools to explain gravity and to completely predict the motions of planets and any other bodies in all space, thus allowing the extremely complex calculations necessary for spacecraft to follow intricately timed trajectories to the moon, the planets and the outer solar system.[13] Venus was now firmly within our grasp.

The Big Bang

With success achieved in our understanding of gravity and the structure of the Universe that we could see with increasingly powerful telescopes, the time was right to consider how the Universe was created. For the first time, humans could seriously discuss the origins of mankind and relate it to the possibility that there may or may not be a Creator.

One idea was consistent with the Biblical idea of an act of creation - the **Big Bang Theory**; another that the Universe had simply always existed - the **Steady State Theory**. Then, in the mid-20th century, an observation was made in the sky that indicated that the Universe was indeed created in an instant. Steady State theories were immediately banished from cosmic minds and the Big Bang reigned supreme - and still does.

The discovery was the observation of a very cold residue of radiation called the **Cosmic Microwave Background Radiation**. It was distributed with great randomness across the entire Universe and was left over, they said, from the creation itself. It was a game-changer. It seemed to many as if we had finally proved that God had actually created the Universe with his instruction to Let There Be Light!

Problems? What Problems?

We are all aware of the many benefits that science has brought us: TV, air travel, medicine and mobile phones. Few of us could imagine life without them. But are we able to answer ... er ... That Question? The answer is No. And there are many more unanswered questions about our world that remain unsolved - even mysterious.

Does it matter?

Well, to many of us, it probably doesn't. However, if humans had always thought that way we would still be living in the Stone Age. It seems that, as a species, humans - as distinct from trees, fruit flies and whales - are uniquely destined to understand everything that is possible about ourselves and our world.

So let's keep going...

By the 1930s, we had set out some remarkable truths about our world. We had determined that 'stuff'[14] is made of atoms and molecules and that the behaviours of the stuff conformed to a strange set of rules that had never been thought possible before.

We had found that gravity controls the formation of galaxies, stars and planets like Earth. It also makes cups of coffee fall off tables when they are accidentally knocked.

All of this was measured with increasing accuracy as the years passed. Many cups were broken along the way and not a single one reassembled itself. Today there is little doubt about these fundamental theories. Let's take a quick look.

The Most Important Theories In The World - No, The Universe...

Here are **THE** two most important things we know about the Universe. These are theories that have provided humans with deep

11 Schrödinger, who was mentioned in my abstract, also made a big contribution to Quantum Mechanics. Humorously, to explain some of the theory's weirdness, he is remembered for proposing a box containing a cat that was both dead and alive at the same time. I refer you to Sabine Hossenfelder for the full comical story.

12 The LHC at CERN took ten years to build and is said to have cost about €5 billion.

13 It is wonderfully ironic that when Einstein examined his beautiful equations, he came to the conclusion that they were not quite right. He decided that he needed to fiddle about with one by including another parameter that was called the gravitational constant. It was simply a 'fudge factor' - a number, and he didn't know what it was. Later, he decided that it was a mistake. Over the decades that followed, physicists argued about its presence and its value. We now know that he was right first time, and, according to Neil Turok's latest work, we have a calculated value for it.

14 I ought to be using the word mass or matter instead of stuff.

understanding and the ability to make precise calculations of many natural phenomena. You may not understand the details (I don't), but you should at least try to remember their names.

1. Theory of General Relativity.

This theory explains gravity. It is the theory of things that are very, VERY big, yet it affects us too since when I jump in the air I fall back down again. That's gravity.

Great minds had puzzled over the way the planets constantly move across the heavens and Einstein finally settled the matter in 1915. With tricky maths, he explained how the Earth is like a ball (isn't it always?) running endlessly around the Sun in an invisible groove or furrow of space-time.[15] Stuck for ever in its groove, like my ten pin bowling ball in the gully beside my lane, it simply can't go anywhere else. All the planets are like this - everywhere. And the Moon has its own little groove around the Earth, and it is stuck there. Trouble is, these grooves are invisible and after looking hard, I've never seen the groove that links me to the ground.

If this sounds crazy, just remember how today's spacecraft follow incredibly complex routes to land on an asteroid or close to a moon of Jupiter. This has only become possible thanks to Einstein's Theory and with the use of computers to calculate where these grooves in space are and how to control the spacecraft into them; in summary, highly complex trajectories. Einstein was not just right - his theory was very, VERY accurate.

Even so, this wonderful theory is still not good enough to describe the whole Universe which is, of course, much, MUCH bigger than our solar system. The latest observations from the James Webb space telescope are already creating difficult questions for astronomers and cosmologists to answer.[16] Perhaps we do not yet have a full understanding of gravity as we look back at the dawn of time? Are we expecting too much?

2. Quantum Mechanics or Quantum Theory.

This is a dense, highly mathematical description of the weird ways that mass behaves to give us the material world we know with all its invisible grooves. Ignoring the dead cats that might yet still be alive, it is the theory of things that are very, VERY small. Most who try to study it in depth give up quickly. (I got to page 2 of the book.) Its outcome is that we now have a picture of what the Universe - including us - is made of. All mass conforms to a thing called the **Standard Model of Physics**.[17](You will be relieved to know that I will not be going there in this essay.)

With these core descriptions set in a broader context that included descriptions of energy (heat) - a subject called **Thermodynamics**[18] - and **Electromagnetism**[19], by the 1930s, we were at a point where it seemed possible to bring all this together - fantastic theories of the very big, the very small and the forces that worked within them into a single Theory of Life, the U...No!

Scientists called it the **Theory of Everything** (TOE). Some might tell you otherwise, but I can tell you now with certainty that they all failed. It simply was not possible, for reasons that will become clear.

The Problem With Science

Donald Rumsfeld found a place for himself in the history books when he said:

> *There are known knowns. These are things we know that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things we don't know we don't know.*[20]

No-one could have said it better. I'm going to take you gently through some of them here.

The trouble with science is that we have become so knowledgeable that we also understand the magnitude of the things we do not know, and that we are almost afraid to talk about.

Some of us believe that we have reached

15 Sorry! Just think of it as space. But that's what everyone calls it.

16 https://www.theguardian.com/science/2023/feb/22/universe-breakers-james-webb-telescope-detects-six-ancient-galaxies

17 Kane, Gordon: Modern Elementary Particle Physics, Cambridge University Press 2nd edn (2017). ISBN: 978-1-107-16508-3.

18 There are three Laws of Thermodynamics that remain entirely intact today. It is the second Law that governs the changes to entropy, a property that is easily expressed as randomness in systems, but which no-one truly understands.

19 The common effects of electricity and magnetism were shown by Scottish James Clerk Maxwell in 1865 to be equivalent. It was a truly momentous discovery.

20 https://en.wikipedia.org/wiki/There_are_unknown_unknowns. Rumsfeld said this in 2002 in the lead-up to the war in Iraq.

an insurmountable obstacle: we know what we don't know, and there are few signs of a breakthrough. The real trouble is that we don't know what we don't know.

Most of the planet's population don't know this is a problem, and if they did, would probably not see it as such. After all, technology is advancing at a great pace and some of us feel that we are already struggling to keep up.

Even if we did know, there may be such inertia in the system caused by commercial, governmental or sociological issues that we sometimes don't want to know.[21] [22]

We have got where we are today by means of a long, logical study of the ways of the world based upon a solid, universally accepted methodology - one that combines deep thought and practical experiment. This is the **scientific method**.

As ideas are put forward by means of what we call the "literature", so they are examined carefully by other members of the community who - with an unbiased approach - decide whether the ideas have merit. This process is called "peer review". By this means, good ideas are accepted and developed.

The essential element of acceptance is that ideas must be independently confirmed by experiment and reproducible by other scientists. Ideas which cannot be reproduced by members of the peer group are discarded.

The scientific method has been developed and established over centuries and has brought us to the great level of achievement and understanding we have today, from the very large scales of the Universe to the very small component parts of the atoms and molecules of which we are made.

So it appears that if time is an intricate part of everything - as it is in **space-time** - and that energy is directly related to mass[23] - and a few other ideas besides - we have largely explained the whole of our modern world.

Or have we?

We could be forgiven for celebrating our successes, of which there have been many. However, less obvious is the fact that there are some big failures. What are they?

What is Time?

Time is intimate to all of us yet has always been a thorn in the side of philosophers. Mysterious too. How often have we thought that time has gone quickly or slowly? I'd bet there is a popular phrase for it in every language on Earth: *A watched pot never boils* ... and all that.

Many great thinkers have proposed explanations, but to have an explanation you need to have a deep understanding. For many years it was thought that space and time were equivalent - that space-time thing again. Einstein used them together in his work. Penrose does too. It clearly works, but is it right? It has taken a long time for the doubts to solidify. We now know - thanks to Wolfram, Unger and Smolin - that it is wrong!

Aaargh! How can you say that?

One important milestone for me was when I discovered the book by Unger and Smolin entitled *The Singular Universe and the Reality of Time*. These two deep thinkers approached the problem from entirely different directions and both concluded that time is not a part of space; that it is **perhaps the most fundamental thing of all** in which the Universe is "immersed." I will show shortly how this is now backed up by Wolfram. I was not surprised by their conclusion, but I was surprised by the length of time it has taken humans to find it out.[24]

Parallel Universes - The Multiverse: The Most Ridiculous Idea Ever Proposed

A further group of reputable scientists began to believe that there were an infinite number of Universes in parallel to our own. It is still a mystery to me how so many brilliant minds could be seduced by such a plainly ridiculous idea.

The idea emerged because of the paradoxical content of quantum theory - dead

21 Eric Weinstein and Bret, his biologist brother, have published the full story about how work on laboratory mice has been suppressed to cover up mistakes in the licensing of pharmaceuticals. https://www.youtube.com/watch?v=JLb5hZLw44s&t=7407s

22 My own work on the dangerous health effects of non-ionizing electromagnetic fields highlights another risk that Society chooses to ignore.
https://soapbox.kentrethewey.co.uk/NIEMF.pdf

23 This is the relationship proposed by Einstein: $E=mc^2$ in which energy is equal to the mass times the square of the speed of light. This equation tells us that when even a tiny bit of mass is converted to energy (as it is in nuclear reactions) a VERY large amount of energy is produced. The knowledge led directly to nuclear weapons and nuclear energy. Nuclear fusion is the conversion of mass to energy in the sun

24 There is also a raft of sociological reasons why we have been held up for so long. I have already hinted at these. I will address them further below.

and living cats, for example. To account for the free will we all possess, they would say that there is an infinite number of mes, writing different versions of this essay all at the same time in parallel Universes. Rather than admit that there might be things they didn't know that they didn't know, they came up with this nonsense. It's not worth further thought.

Suffice to say that those great minds I have mentioned above all believe there is only ONE Universe.

Why Is There No Time Travel? Hollywood Thinks There is

Science requires observations in nature to be rationalized into sets or groups of behaviour that are expressible by mathematics. In particular, systems that change with time contain it in their equations. These equations allow the prediction into the future of the behaviour of any similar system, as long as we know certain things about it. This has been the great power of science and why it has been so good for us so far.

However, a most important problem that emerges is that the **mathematics and physics allow systems to go backwards in time as well as forward**.

Time travel is an obvious attraction to Hollywood script writers but we all know deep in our bones that it is entirely **impossible** to go back in time and highly **improbable** to go in a forwards direction.[25] How could anyone seriously believe that I could travel back in time and change events so that I am never born? Imaginative scriptwriters as good as Stephen King[26] may like to create ways of beating the logic, but we all know it's just fiction.

Finding A Theory Of Everything Is Not Possible With Conventional Science

From the 1930s until the 1970s scientists lived in a beautiful world where everything was like a giant jigsaw puzzle with all of the pieces on the table. Excitedly, they beavered away trying hard to fit the pieces together but they could not do it. Surely, there was so much beauty and symmetry on show that the pieces would fit? Some did;[27] too many others did not. Their efforts drove them to increasingly arduous, abstract (and costly) extremes on the basis that all that was needed was better maths, more fudge factors and a few more atomic particles, but in 2023 success has been achieved only in the brains of supporters of two similar hypotheses known as **M-Theory** and **String Theory**. These string theories have remained strong for forty years, but have not delivered the results that were expected. There remains a large cohort of scientists who believe the puzzle is still incomplete and are not at all content that string theory is the basis for a Theory of Everthing. Some minds - such as Penrose, Unger, Smolin and Wolfram - have concluded that the puzzle is not solvable by conventional science.

The Problem Of The Gravitational Constant

The theory of general relativity has been dogged by arguments about the presence of a number called the **gravitational constant**. Einstein put it into his equations at first, then took it out again, thinking he had made a mistake. Today, most scientists believe it must be present but are unable to agree on its value. This has a profound consequence for the ultimate progression of the Universe and the amount of matter in it. Having said that, there is a current (2023) claim by Neil Turok of the University of Edinburgh that he has been able to calculate the value of the constant from first principles. If his claim is verified it will have been a remarkable achievement. He also has a brand new (2023) **Theory of the Universe**.[28] Commendably, Turok has approached the problem by promising at the start that he would not fiddle with the equations, add in new parameters or propose new particles. He claims to have succeeded.

Why Does My Coffee Never Warm Itself?

In this real world, I can precisely describe the motion when I throw a ball into the air, but the ball never reverses its direction and

25 There are circumstances in Einstein's work where timescales can change by travelling at close to light speeds. This is called time dilation in Special Relativity, but only works in the future direction. No-one and nothing can go back in time.

26 The wonderful book titled 11/22/63 is a novel by Stephen King about a time traveller who attempts to prevent the assassination of United States President John F. Kennedy, which occurred on November 22, 1963

27 Electricity had been fitted to magnetism and later these were fitted to the weak nuclear force that gives rise to radioactive decay. Fitting these to the strong nuclear force was also possible, but gravity was always the outlier, resisting all attempts.

28 https://sms.cam.ac.uk/media/4204431. Scientists seem unwilling to call it a Theory of Everything (TOE)these days.

comes back to me. (I have my doubts about boomerangs!) The arguments extend easily. Thus, if I knock a cup of coffee onto the floor, the shattered pieces never re-assemble themselves.[29] And, once the brown nectar has gone cold, it never spontaneously warms itself up again. This involves another very important thing called **entropy** that no-one fully understands either.[30] So mathematics predicts many things in the world really well, but the world never reverses itself as maths says it could. This illustrates that we still have no clear idea about time and many scientists believe that their colleagues have been locked into a grossly distorted version of it since it was expressed in a particular way in the theories of Relativity. Time and space are **not** linked in the way we think they are; they are fundamentally different - a rare victory for common sense over science, another being that there is only **ONE** Universe. Yes, really!

The Missing Mass And Energy

There are many other problems of failure of fundamental science, especially where it concerns the Universe. I do not have time here to describe them all, but I could replace them all with this one:

96% of all the mass and energy calculated to be in the Universe is missing!

Yes, you read that correctly - 96% of the Universe has not been found and cannot be detected by any means yet known to us.[31] Scientists are still trying to understand this and there are no agreed answers using standard science. Many of them expend their energies looking for it, whilst others (too few)plaintively raise their hands and shout that there just might be something wrong with the theory.

We are certain that the Universe was created by the Big Bang, but in order to make this remarkable theory match observations (supposedly explainable by mathematics) it was necessary to cheat and introduce a 'fudge factor' (yes, another one) into the theory known as **Inflation**. Fortunately, it is not affected by decisions of the central banks or we would all be in serious trouble. This type of inflation remains there to this day, no matter how much banks lower the interest rates.

To account for certain observed features of the Universe, inflation was plugged into the equations, a factor that allowed the Universe to expand very quickly[32] like a balloon being blown up by car tyre pump. It has been questioned by some of our top thinkers[33] but is still part of the substantiated theory of the creation of the Universe. I am not aware that anyone has linked the need to fudge the mathematics with the missing 96% of the Universe. This alone should leave everyone in doubt about our true understanding of the Universe.

As of 2023, Neil Turok has suggested that the dark matter is in fact one of the three right-handed neutrinos and that this will be proved by experiment in a few years time. In Wolfram's Theory, about which I will talk more shortly, we now have an explanation of what this missing stuff is. According to his model, it arises naturally as a new family of particles that are so small they cannot be measured with today's technology.

The Continuing Absence Of An Explanation For The Existence Of Matter And For The Interactions Which Govern It

The quantum theory is a very difficult concept for most people to understand, but those who do are extremely comfortable with the ideas and are able to make precise calculations involving the many subatomic processes that they have been able to measure since the development of high energy physics. With these tools it has been possible to come up with the standard model of particle physics to describe the fundamental building blocks of everything in the Universe. Those who have studied chemistry will be familiar with the Periodic Table of Elements as a description of the materials we come across every day, and we would expect that this is an area in which we have a good, overall knowledge.[34] Particle physicists, however, have been able to pull the atom apart to study the materials of which all

29 This is not just something that involves thermodynamics and entropy, but another reason not to believe in backwards time travel!
30 Sir Roger Penrose has made a very good shot at it.
31 Strictly, the science divides this into dark energy and dark matter, but remember that Einstein told us that they are interconvertible anyway.
32 The expansion time lasted from 10^{-36} to 10^{-32} seconds after the Big Bang, an unimaginably short time.
33 ... Roger Penrose is one.
34 Even so, we still have no idea where all the water on Earth came from. There's a LOT of it!

these elements are made.

Including various kinds of particles and all of the forces that operate between them, a table rather similar to the periodic table is the result.[35] The conclusion is that all possible forms of matter have now been identified and every possible interaction between them is identifiable by an exchange of force-carrying species.

The recent (2012) well publicized discovery of the Higgs boson and its existence in the Higgs field, a situation that occurs only at the extremely high energies of the very early Universe, means that the final piece of the jigsaw of the standard model fell into place. In almost all of the final stages of the process, scientists had made predictions about the existence of these species and were proved correct by experimental observations at the LHC of CERN. Surely, they thought, this must be correct!

Nevertheless, there is something deeply unsatisfying about the picture. No quark has ever been observed on its own, neither have many of the other particles. Some of them remain the creation of complex mathematics.

Whilst the four, fundamental forces of nature are now well described, (gravity, electromagnetism, weak, strong forces) it is still a mystery how a field actually projects a force. The strongest three forces have been shown to be unifiable by mathematics, but as of 2023 no-one has succeeded in adding gravity to the other three with the agreement of the scientific community.

The supposed expression of a force as by means of an exchange of particles, whilst being accepted in theory, remains open to disproof.

Another curious feature is that, although atoms and molecules are well known to carry units of charge, the quarks from which they are supposedly made carry their charges in thirds - a most suspect quantity since there is nothing precise about a third of anything.[36]

One thing we do know for sure is that we are no further on in our quest for an understanding of what matter actually is, neither do we have any idea about what conveys the properties to the various particles that we have supposedly discovered and named. We are really no wiser in answers to the questions, What, Where and Why?[37]

The Problem Of Black Holes And Their Role

Some my favourite memories of films in my youth were the scenes in which the Blue Meanies[38] were a dangerous people with vacuum cleaners on their heads. Their world was littered with black holes scattered over the landscape and at first the Blue Meanies went about their business hoovering them up. Later they began sucking anything and everything into themselves. After hoovering up each other, the last remaining Blue Meanie sucked himself out of existence to leave total emptiness. It's a superbly humorous parallel to the predicted future of our Universe where we replace that nasty little devil with a genuine **Black Hole**. Now we're getting serious: this guy is a real bogeyman!

Black Holes have been proposed by astronomers since the middle of the 20th century, and are now well known to exist.[39] Indeed, it is thought that there is a black hole at the centre of every galaxy (including our own Milky Way) from where, like an evil overlord, it controls the development and lifetime of the galaxy under its jurisdiction.

At first the black hole was assumed to be an irresistible force that sucked literally everything into it, from which nothing could escape. However, the behaviour of black holes has now been shown to be more complex. We now know that black holes have finite size and can be shown to have an enormous equivalent mass, depending upon how much has already been sucked into it. However, what goes on inside a black hole remains unknown.[40] Current thinking[41] is that the Universe may have been created from a single, humongous black hole and that, in the far distant future, the Universe may come to an end as all of the matter in it eventually becomes drawn into a similar enormous black hole.

The Sociological Problem Of Fashion

35 https://en.wikipedia.org/wiki/Standard_Model

36 In maths, a third is 0.3333333... It's not what you call, precise.

37 Don't expect physicists to protest too loudly about all this - their jobs depend upon it staying like this.

38 The Blue Meanies were characters in the wonderful Beatles' cartoon, Yellow Submarine (1968).

39 Stephen Hawking's fame has been largely built upon the study of Black Holes, amongst other things.

40 Stephen Hawking was awarded his Nobel Prize for discovering that Black Holes can actually slowly lose energy in a form called Hawking Radiation.

41 Sir Roger Penrose. See his book Cycles of Time.

It might seem at first that fashion is an odd factor to consider, but in a world where science depends upon finding funds allocated by non-expert governments, it will always be the case that the projects that find the most funds will be those that are considered fashionable, that is, they have the most momentum at a given time. Conversely, projects that involve tearing up the textbooks, as it were, are far less likely to attract support.

Once again, it has been Penrose who faced the problem head-on in his book, *Fashion, Faith, and Fantasy in the New Physics of the Universe*. There are two great problems of fashion at present. The first is the desire to solve some of the riddles just outlined by means of a multiverse, that is, the idea that we inhabit just one Universe of many, that there is an infinity of Universes in which alternative physics can take place. This is supposed to satisfy the demand for answers as to why our own Universe is so special.

The momentum for acceptance of the principle of a multiverse has been mostly derived from the second great problem of fashion - the continued development of ideas under the general heading of string theory, a theory of quantum gravity.[42] The theory has come about because of the need to understand physics at the smallest sizes imaginable. Here the concept of Planck units comes into play. These were devised to allow measurements in units that can be derived from natural sources, rather than by humans. In particular, distance is measured in units of 10^{-35} metres, and time as 10^{-43} sec. The units depend only upon the free space in the Universe and although first proposed in 1899 by physicist Max Planck, they have been developed recently in projects trying to unify gravity with the three other fundamental forces - an objective that has eluded the most intensive scientific enquiries since Einstein spent the remainder of his life working on it. String Theory has grown out of this work in the search for the graviton, a particle that has been predicted to carry the gravitational force. All of this presently most fashionable work has so far run into the sand as far as making the single leap forward that scientists have expected.

42 Remember that the problem of integrating gravity into the quantum world has proved so intractable that desperate measures were called for.

The Problem of Information

Yes, there are still more problems to report. Many scientists may not realise that there is a problem of information, for there is presently no good theory of information - a result that must indicate that there is no perceived need for one. This is a curious omission given that we live in the Age of Information which is so crucial to everything we do today. The problem of information was thoroughly addressed in three books published in the 1990s by Tom Stonier[43] who presented some excellent ideas towards a new theory. Unfortunately, he seems to have been something of a lone voice, silenced once again by the doubters populating the mainstream.

Paradoxically, the Universe is constructed on information because it has been made clear on countless occasions that the laws of physics depend upon a group of fundamental constants that are part of the fabric of our Universe. One explanation may be that it is subsumed within the standard model of particle physics, but this has not yet been explicitly demonstrated, nor has it been applied to the wider context of events during the life of the Universe, whether human or otherwise.

One of the most significant points made by Unger and Smolin in support of their arguments about the uniqueness of time is that the Universe clearly has a history, even though we may not go back in time to inspect it. The question is, where is this history stored? And if there really is a fundamental repository somewhere, might this allow us to contemplate meeting our ancestors somewhere after our death. Aaah, I am letting my imagination get the better of me.

The Problem Of Artificial Intelligence

Despite what you may hear in the media these days in relation to AI, no-one understands human consciousness, and we are definitely NOT able to reproduce the thought processes of the human brain. This remains a serious problem for scientists who are perfectly able to make increasingly powerful computers having greatly more storage capacity and speed of calculation. However, for the foreseeable future the theory of consciousness will remain a mystery, especially

43 See Further Reading section.

in relation to the ideas of information theory and its absence. Meanwhile there is a serious side issue of the existential threats to humankind because of the kind of possible scenarios such as those portrayed in movies like *The Terminator* - although NOT with time travel included.

The Problem Of Understanding Reality

The very nature of reality has come under intense scrutiny, with arguments directed mostly within the context of the present poor understanding of the Universe. In some cases, ridiculous conclusions such as multiverses have been presented as possible explanations.

Common sense (whatever happened to it?) would suggest that there is something of much greater significance that is either unknown or misunderstood.

The good news is that it might be with us now. The time is right for a paradigm shift.

PART 2 - The Current Paradigm Needs To Change

The disappointing situation I have spent some time describing is now so deeply embedded into our science that it is career-limiting for working scientists to criticize it. Anyone trying to rock the boat of science gets short shrift from the community with its many vested interests. These scientists rest on their laurels, smug with their successes, yet refuse to acknowledge the gaping holes in their theories. Like supertankers, midstream, it is now too difficult for most of them to change course, locked as they are in to the funding mechanisms available to them. All work requires financial support without which they are unemployed, and who wishes to support anyone with seemingly outrageous ideas?

In this way, science and scientists have been constrained for years to working within a framework and methodology that cannot deliver certain answers. They promise that further study and improved measurements with ever more expensive equipment will provide these answers, but, rather like the promises of bounteous, clean energy from fusion, never materialize.

Above, I mentioned Stonier who cried out in the wilderness. The Weinstein brothers have their axe so firmly planted on the grinding stone that they have avoided the scientific literature entirely after becoming the victims of deceit and unprofessional conduct. Penrose has best avoided unwarranted criticism because he has been so careful to keep his doubts within the academic mainstream.

Another critic who should not be ignored is Rupert Sheldrake who has received much unreasonable flak for his ideas expressed in several books, notably *The Science Delusion* (2012). Deliberately titled to parallel the well known author, Richard Dawkins[1], Sheldrake goes to considerable lengths to doubt the forthright atheist platform on which Dawkins has promoted himself for over three decades.

Sheldrake describes his theory of Morphic Resonance[2] which he uses to explain some of the unsolved scientific problems, especially the one of consciousness, and there is also a distinct link to Stonier's discarded ideas that ought to tempt further exploration by curious minds.

Rupert Sheldrake is a scientist with a background in biochemistry. He is not part of the cohort of computational scientists I am concerned about here. However, he is excoriating in his view of scientists who refused to accept that it is time to adopt new methods in science.

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1 One of Dawkins' many titles promoting his atheism and the idea that we are all just biological machines is The God Delusion.

2 At this point, I am minded to relate a story that concerns my own experience with Sheldrake's observations. As a research student at Leicester University during the period 1972 to 1976, I myself created a number of chemical compounds that had never been synthesized before. my thesis supervisor, Professor Stephen Davidson, had earlier told me that one of the reasons he chose me to be his research Student was because he had seen my skills as an undergraduate at crystallizing solids from their liquids. Sheldrake points out that when a compound is synthesized for the first time, it has no previous history in the solid-state, and in his opinion, according to his own researches into the subject, compounds synthesized in this way, may take a very long time to adopt a particular crystal structure. However, once that novel material has a history of existence in a particular structure, All subsequent syntheses of that material crystallize far more easily. It is almost as if the materials know which crystal structure they must adopt. Sheldrake even describes cases in which novel materials adopt one structure, but then seemingly change their minds and later adopt another. Thereafter, the first structure is never seen again and all subsequent crystallizations adopt the second structure. In my own experience of synthesizing new chemical compounds, it saddens me to report that I do not particularly recall observing this phenomenon. That is not to say that I disbelieve Sheldrake. It just means that I am not able to support his argument. Nevertheless, I feel that it could be distinctly believable. I was always very moved at the thought of bringing a new species into existence. It was my own male equivalent of giving birth! I considered it a great privilege to be able to create things that had never been seen before, but then I suppose it's no different from having a baby.

The Missing Tools

Even scientists from the mainstream have tried over many years to solve these serious problems with our understanding, but I believe they have been prevented from doing so for a number of reasons. First has been our capacity to solve very hard sums - well, the lack of it actually. Computers became available on a mass basis only from the 1980s and there is no doubt that since then our capacity to examine difficult questions has expanded beyond expectation. Its continued expansion into the future promises to yield wonderful results in quite a short time.

The second thing that has held science back is curiously linked to the first. Scientists have become imprisoned by their own culture. Progress in science has been made within a framework of publication through what is called peer review whereby scientists write down the results of their experiments and obtain the agreement of their colleagues before the ideas are released into the community. This self-policing has unquestionably saved science from crazy ideas emerging from those who are unqualified to speak on a subject. Regrettably, some have put Sheldrake in this category. However, the need to use mathematics and the development of reproducibility of experiment seems to have constrained science from understanding a huge new area of exploration that has now been demonstrated by Stephen Wolfram in his book, A New Kind of Science (2005).

Out With The Old, In With The New

I have devoted a lot of space to the many problems and it is time to summarize the issues.

I have described shortcomings with:

Relativity Theory - the gravitational constant and gravity itself;
Quantum Theory - the lack of fundamental understanding;
Human Evolution and Intelligence.

If we are to move on from a situation in which we claim to know so much about ourselves and our world but don't actually know the answers to so many questions, we need to re-think our position using some new ideas.

The New Physics

It's been a long time coming!

Since the 1980s I had been contemplating the answer to *the greatest question ever asked*, and had observed occasional lights in the fog. I have already mentioned books that gave me cause for much thought and I have added comments in the section on Further Reading.

After graduation in chemistry, with my first degree I knew how much I didn't know. When I started my research program I was embarrassed by the amount I still didn't know. I recall attending a seminar by chemistry Nobel laureate, Roald Hoffman who, in answer to most of our questions admitted he didn't know. It made me feel slightly better about my own lack of knowledge, but the feeling didn't last and it seemed a lot worse when I was awarded my doctorate. I was lucky to embark on an academic career, knowing that I didn't know a lot. I quickly learned some stuff and, feeling that I might know something at last, I decided to help less knowledgeable students by publishing what I did know in a textbook.[3] There was so much that all of us didn't know. What was worse, there was so much that we thought we knew and didn't. Sorry, it's that Rumsfeld thing again.

Perhaps the biggest revelation was made on my birthday, of all days. It was 2015 when I visited the University of Oxford bookshop and found the book by Unger and Smolin. It was life-changing for me. Their superbly argued thesis was that:

There is one Universe;
Time immerses everything;
Mathematics cannot be used for every analysis.

The authors further argued that it was time to conduct science with new methodology based upon the principles they were proposing. It was a wonderful start to the new paradigm. It became my Bible. Unrecognized by me, there was a much more detailed model in gestation, based upon forty years of intensive work *outside of the science community*, by Wolfram. The key was computability.

3 K R Trethewey, Chamberlain J, "Corrosion for Students of Science and Engineering." Longman, 1988, ISBN 0-470-20794-9; Indonesia edition, 1991; PR China edition, 1992. Ironically, my publisher was the man who published Richard Dawkins' first book, The Selfish Gene.

Things That Are Not Computable

James Gleick published his book *Chaos* (1987) to much applause, including from me. At last we had a way to explain some of the natural phenomena with which we were so familiar, but which had escaped the usual kinds of scientific analysis and explanation. Gleick, it turns out, was at last describing systems like the patterns of weather and fluid flow that are computationally irreducible. I'm not sure if he was exploring the same avenues as Wolfram was also discovering, but it doesn't matter. He certainly sub-titled his work *Making A New Science*. Yes, he discussed explanations in terms of traditional mathematical analysis, and despite making much progress in an otherwise intractable science, it did not greatly impact the traditional world of physics.[4]

Contributions by Sir Roger Penrose

It was a book by Roger Penrose entitled *The Emperor's New Mind* (1989) that set my pulses racing. Penrose worked with Stephen Hawking who, for other reasons attracted more fame and attention than Penrose, who actually deserved it. Penrose contributed a great deal more to the lexicon of physics and maths. He has become a pillar of the scientific establishment and was awarded the 2020 Nobel Prize for physics. He was in no doubt about the sacred nature of the great laws of physics in the overall scheme of things but was a rare reporter of his disquiet about the many glaring holes in physics, not least of which was an explanation of consciousness.

I became a strong supporter of Penrose as, until then, he had been the only Supermind in my sphere to criticize these obviously error-ridden theories. I have followed his work extensively since then and, as I write, I believe he still has no explanation for consciousness, although he has made some significant steps forward. It was a chance association with an anesthetist that helped him greatly. His colleague was a professional in the control of consciousness as he went about his daily work and he had discovered that there were structures in the brain known as microtubules. The use of anesthetic under controlled conditions could turn consciousness on and off, and it was known that the chemical was interacting in some way with these microtubules. This was a major development for at least consciousness had at last been isolated to a specific part of the brain.

A logical extrapolation would be that living organisms without microtubules night not have consciousness. Perhaps organisms with no definable brains are not conscious - plants could be a simple example. I can confirm that the two dogs in my life - Quinn and Hagrid - have consciousness, and I feel sure whales could also pass the test, but what of the fruit fly? This is the situation that pertains today, as far as I know. However, it would be easy to argue against it.

The subject is fraught with difficulty, if only for the complications of the use of language. For example, we also must consider the bedfellows of consciousness - Intelligence, Understanding and Awareness, all four senses that are subject to the subtleties of the English language.

Penrose believes that Intelligence requires Understanding and Understanding requires Awareness. He feels that Consciousness is on a different level, but cannot be definite. These features are not the same and in his thinking the terms represent levels of biological development.

It makes a lot of sense. A tree is aware but a stone is not. The tree is aware of the climatic conditions in which it lives and changes its physical existence depending upon levels of temperature, rainfall, sunlight, etc. The stone could not care less. This represents a good way of separating living things from 'inanimate' objects. All living things must have awareness of some kind in order to survive and reproduce. However, awareness does not award understanding.

I find it hard to attribute understanding to a tree, although I would not wish to rule it out. Understanding implies a measure of thinking, which must surely require some sort of brain? We start to get into murky waters if we try to go further. Surely, the tree's awareness of changes in its environment produces a reaction that is a pre-programmed response held within the atoms and molecules of the tree's microstructure.

I believe that our bodies can be aware

4 Gleick's work led me into the world of fractal geometry - one that I investigated for the next five or six years of my own scientific career. It was fun and marginally successful, but made no significant impact, of course.

without the need for thinking and all the other responses that follow. If I cut myself, the skin cells get on with a biologically pre-programmed procedure of repair. I do not believe that my brain needs to take charge of that. Indeed, Penrose might argue that the body's functions carry on normally whilst consciousness has been turned off by anesthetic.

I don't think I could deny thinking to my family's dogs, or to whales, and I feel sure that modern convention would associate intelligence - and certainly consciousness - to both species. Whether the fruit fly has any capacity to think I have no idea. I would guess not, but I feel as if I am dodgy ground as I will expand upon in a moment.

Here's the Answer We All Should have Been Looking For;
It Has Finally Been Provided By Stephen Wolfram.[5]

It is my humble opinion that, with his New Physics (2020), based upon his earlier work, Stephen Wolfram has finally devised a model for the Universe that can provide the most comprehensive answers yet given by humans; it should be regarded as a paradigm shift.

Wolfram's name is still absent from many of the current scientific discussions, despite his major new step forward. This intimately involves computers and things they can do that mathematics cannot.

Here is something stupendous, that we sort of already knew, but which the scientists we have trusted never actually accepted. They thought that everything could be expressed by mathematical equations.

JARGON ALERT! Wolfram calls things expressible by mathematical equations **computationally reducible**. It's fairly obvious that things that cannot be expressed by maths are **computationally irreducible**.

It is important to note that being computationally irreducible does not mean that it cannot be represented on a computer. Indeed, it is the opposite: we need computers to examine them. This is why this *New Kind of Science* is being proposed.

Here's the thing...

Our Universe is computationally irreducible.

It means that the entire Universe can NOT be described by mathematical equations.

Now, you should be confused because I told you above that there is a lot of it that is expressed beautifully by Relativity Theory and Quantum Mechanics. However, what no-one realised is that the Universe is unimaginably more complex and made up of different parts, **some of which can be calculated and some that cannot**.

This is a BIG thing because scientists have not been thinking like this until now. Thinking like this gives us an enormous opportunity to explain things that science has so far failed to achieve. It arises from Wolfram's work described in just a few pages of *A New Kind of Science*, (NKS), but explored very comprehensively in more than a thousand other pages. His recent book, *A Project to Find the Fundamental Theory of Physics* achieves in its first forty pages what scientists could not in the 20th century.

Here is the Answer to That Question (as provided by Stephen Wolfram)

I am going to present my very simple take on what is a VERY deep philosophy, yet which seems to have a remarkably simple origin.

We know that great complexity is present in the Universe, and one of the best examples of great complexity is to be found in a human. Where does this unimaginable complexity come from?

In his book, NKS, Wolfram found that it is possible to apply very simple rules to very simple structures and get extremely complex results. We say that, from a simple beginning, complexity is **emergent**. This complexity lies outside the realm of mathematics, but can be shown by computers that iteratively apply these simple rules to simple situations that could easily be thought of as atoms, molecules or basic biological structures. (In the biological

5 It is a frustrating thing to me that I knew about Stephen Wolfram and his work way back in the 1980s. I came across his ideas about cellular automata and the proposal that they represented biological processes, but I was not ready to fully appreciate that idea at the time. Later I came across Wolfram Mathematica and his wonderful software for carrying out mathematics on a computer. Since I was by then not really working with serious mathematics, I passed it by. So it is only been relatively recently that I rediscovered Wolfram in a video on YouTube and I was very impressed by his presence and his knowledge and quickly realised that I had missed something big. I realised he had produced a book in 2005, entitled A New Kind of Science, and I bought it right away. At once, I realised there was something very big within its many pages.

context, developed in the 1980s by Wolfram himself, amongst others, this subject became know as **cellular automata**.)

I would describe this discovery as the first proper path to understanding where complexity in nature comes from.

Computational irreducibility

Yes, that term again.

Something that is computationally irreducible cannot be calculated with a mathematical equation. Precise values of parameters in the future cannot be found.

It means that it is not possible to tell me with absolute certainty if it will rain on my house tomorrow at midday. The best we can do with the world's biggest computers is to give me a probability.

Set against that, the difficulty of landing a probe on Mars with an accuracy of about ten metres. We can do that! So why can we do such complicated space flights and yet not be certain about the weather tomorrow? The reason is that there are no equations to compute the weather, whilst Einstein's equations can calculate the trip to Mars with extraordinary accuracy. If the probe lands a hundred metres away from the target, that's the fault of the engineers, not Einstein. (Please take note Mr Musk.)

But what's the equation for an eye? And what's the equation for the taste of an orange? More seriously, what's the mathematical equation that predicts the formation of DNA from four very simple chemicals called amino acids?

If, in each case, you think that all we need is a more complicated equation, then you are wrong. Read the words again. **There is no mathematical equation to describe an eye or the taste of an orange or to show DNA formation.** It's because of Wolfram's discovery about computational irreducibility.

What is truly remarkable is that Wolfram's model shows how the complexity of each situation can arise. It provides many explanations as to how answers to currently unanswerable questions can be found.

OK, so if the Universe is computationally irreducible then why is such a big part of science successfully described by maths and physics?

The answer is quickly found by looking at Wolfram's early pages. Within the complex structures that emerge from his simple systems, there are randomly placed localized patterns, in other words, there are parts - many or few, large and small - of the system that **do** conform to computational reducibility, whilst the overall system does not.

What Are The Implications For Life On Earth?

Returning to the subject with which I began this essay, apart from Creationism - which is a theory from a pre-enlightenment part of our history - the only theory that relates to the development of life on Earth is that of Darwin. The theory, largely unchanged since the mid-19th century, remains the only credible explanation for life on Earth. Amongst the scientific community, it has become almost as difficult to criticize as Creationism. Yet even the most cursory consideration of Darwinism quickly raises questions that are difficult to answer. By far the most difficult question for supporters of the theory is whether the time available for evolution is sufficient to explain the complexity of the millions of creatures that have evolved. Darwin's disciples say that clearly it **is** sufficient, but have no method of substantiating their argument in the accepted scientific way.[6]

No sooner do you understand the implications of what Wolfram has discovered than you realise that **evolution is computationally irreducible**. In other words, the development of life on Earth does not conform to the standard methods of physics and mathematics and could never be explained by such methods. Although some elements of the *Survival Of The Fittest* hypothesis are correct, **the Darwin theory does not contain the necessary elements to fully describe the origin of life**.

In total contrast, the complexity that develops in Wolfram's model in a relatively small number of generations is a good indication that this is where the explanation actually lies.

A rather simplistic thought occurred to me that, even as long ago as the time of the dinosaurs, creatures had eyes - a very complex development in evolution that has

6 I wanted to include this problem of evolution within my section of the problems of science, but that was getting too big. I like it here.

not changed significantly over the millions of years since. Why would an eye emerge so quickly in evolution, whilst other features have taken so much longer? These are the kinds of suggestions that might have explanations in conventional Darwinian Theory, and would probably be thrown back at me by mainstream scientists, but are not necessary to invent using Wolfram's models.

It would clearly be a great disappointment for supporters of Darwin to be told that their cherished ideas about Natural Selection and the Survival Of The Fittest are not entirely correct - if they are correct at all. Wolfram himself is not convinced.[7]

You could argue that - sadly - Wolfram is telling us that the answer to the question of whether life forms can be just machines following programs of instructions is Yes. That might arouse a feeling of dismay amongst theists. However, that is an extremely simplistic approach to the problem, for it considers only a very limited aspect of the subject - the assembly of the molecules. We are left with all the other aspects such as awareness, understanding, intelligence and consciousness that are, so far at least, still unexplained.

After forty years of deep thought and study, the final piece in my personal jigsaw was provided by Stephen Wolfram. I have arrived at a point where my intellectual heroes - Penrose, Unger, Smolin and Wolfram have led me to a point where I can rest in peace. There could indeed be a creator of everything, and it is still possible that I might one day be reunited with the love of my life. I'm sorted; good luck to all atheists.

The Wolfram Model

This section has been extracted from Stephen Wolfram's extensive writings and videos. It is simplified as much as possible so as to try to communicate the ideas more clearly.

His work relies upon many computer-drawn diagrams that often have much complexity and are not suitable to reproduce here. My explanation attempts to put words to his basic idea so that all readers may gain insight. Obviously it is not possible for me to do proper and full justice to this remarkable theory, which Wolfram backs up with rigorous analysis and proof. My intention is to announce that we should all be aware that this theory exists and that, at last, a big, new improvement to an outdated, failing analysis of our Universe is available. I am distinctly conscious that the new understanding gained might help many readers with their faith.

Readers without a background in some of these concepts may struggle. I hope not. In the first place, there are numbers - both big and small - that defy comprehension. I try to avoid this here, for even technical minds find the scales beyond imagination. Then, for a human to cope with ideas in more than three dimensions requires an open mind, unconstrained with the usual rules.

Language, too, plays a big role. When working on an idea such as this, it is inevitable that words already in use in the English language may be used in a new, broader context. Sometimes it is necessary to invent words, but for clarity to those who wish to understand this difficult notion I use familiar words – often with alternatives - on the basis that their normal meaning should be expanded a little beyond the usual.

A further important point is that, with the very good reason that is derived from his theory of complexity, this model must be computable[8] and so **the usual mathematics of traditional physics works only within sections of this model**. Wolfram is saying that the entire Universe cannot be described by mathematics alone.

The Physical Space

It seems to be the most logical approach to start by creating something from nothing - to create a **Space** for the Universe to exist. Nothing else is required at first, with no specification of the number of dimensions.

Wolfram begins by saying that space is made of Something which is, on its most fundamental scale, identifiable as discrete 'points' or 'nodes' or 'locations' in that Space.

7 His arguments are laid out on p392 of NKS.

8 In consideration of the enormity of the numbers involved, it is likely that present computers will not have the capacity to carry out the number of computations necessary and that some analysis will need to wait until new computers of sufficient power become available. Again, we need to remember that we are not projecting or predicting some future behaviour by simply entering values for parameters in some mathematical equation set up in physics, but instead carrying out the same kinds of stepwise changes to models in the way the Universe is doing it.

These points should be connected in some way to make a network. This should be regarded simply as a Physical Space.[9]

Instead of Things let's think of Atoms or Points or Nodes of Space.[10] They are not traditional atoms; these points are incomprehensibly smaller than actual atoms. A name is required for these 'atoms' of space and Wolfram has suggested 'emes'. So these 'emes' are discrete 'atoms' of space. Their only feature is that they exist, and each eme is distinct from every other eme.

Relationships Between The Points In Physical Space

It would be pointless to proceed without expecting these points to be in some kind of contact or relationship with each other. Nothing would happen. We might expect one point to have some kind of relationship with others that are close; however, it might be unreasonable to expect every point to have a relationship with every other point.

How do they relate to each other, i.e. which Node of Space is related to another Node of Space? There need not be only one relationship: there could be multiple relationships from one node to another and if we could see all of these relationships they would look like a tangle of lines – a kind of space spaghetti.

Everything we experience results from the features of this Space. Everything is a result of some tangle in the structure of Space. Everything that happens in the Universe is the result of a constant storm of nodes reacting with other nodes through these relationships at incomprehensible speed.

Representing It - The Hypergraph

How can what I have just described be represented? School geometry taught us how to plot graphs on paper using two co-ordinate axes, x and y. The points on the graph are called Cartesian Co-ordinates.

If we wish to represent things in three dimensions then we add z as a third co-ordinate. We are used to calling these things graphs.

Notice how we are content with the concept of representing three dimensions on two-dimensional paper. We created a way of drawing 3-d in 2-d. Our problems occur if we try to add another dimension and draw 4-d in 3-d. This was what happened in Einstein's space-time when it was decided to combine space and time.

My comment here is that this was not wrong! Clearly it works because Relativity Theory is well proven. However, **it does not mean that time is actually the same as space**. Indeed, it is quite different, but can be made to work with space in the restricted context of Relativity Theory. We will shortly see from Wolfram's Theory that **Time is fundamental to Everything.**[11]

In science it is common to need to represent ideas in multiple dimensions and we cannot do this on paper without gross simplification. Mathematics is not bounded by pen and paper in this way and so higher level maths invokes tensors (multidimensional measures) instead of vectors (three-dimensional measures), for example.

If we consider two points on a 3-d graph and join them we can think of the result as a line or an Edge. Three points joined would be a plane. This is like our Wolfram Space except that in this we now have **undefined** dimensions. The description of Space and its elements is represented by a **Hypergraph**. If two points of a hypergraph have relationships between then they make a **Hyperedge**.

Relations Between Atoms Of Space

There are collections of relations – like spaghetti - between Nodes of Space. Now Wolfram's fundamental idea is invoked: that simple rules are continuously being applied to this Space, now described as a Hypergraph. His discovery – currently extremely well documented[12] – is that **great complexity can evolve from the application of simple rules to a system**.

Remember: a hypergraph is a graph in multi-dimensions. Two nodes or points in a graph can be related, and the relationship is denoted by an edge in the graph. In a hypergraph there can be more than two nodes related on a hyperedge. **The whole Universe is represented by this hypergraph**. You can

9 Wolfram has estimated that there are possibly 10^{400} atoms of space in our Universe.

10 Wolfram likes to call them atoms of space.

11 ... as proposed by Unger and Smolin.

12 Wolfram - A New Kind Of Science.

have any number of things on a hyperedge of a hypergraph. Everything we experience - like electrons and photons and gravity - are all just features of this hypergraph.

Elementary Events

An elementary event is when one node of a hypergraph is affected by a relationship with another. We call a relationship a **Rule**. This is a **Causal relationship** in which Node 2 is changed by the rule of a relationship with Node 1. It is an **Event**. Node 1 causes a change in Node 2 because of the application of a Rule. The affected node, Node 2, has changed and must be rewritten. That is an **Update** to the Space or Hypergraph. In other words:

> *"Every time you see a bit of hypergraph that looks like this, update it to something that looks like this."*[13]

This is how the Universe fundamentally goes about its business. The duration needed to perform the Update is the fundamental length of time.[14]

My translation of this therefore is that:

> **Beginning with Physical Space and applying the Rules across all of the Nodes creates us and the entire Universe.**

In its simplest sense, this describes the entire Universe and its evolution. Is that not entirely amazing? It is so startling that I will rewrite it:

We have a model for the entire history of the ONE Universe in which EVERYTHING is changing over TIME, which is itself NOT REVERSIBLE.

The consequences of this idea cannot be overstated. The entire set of nodes is being affected by different rules and each node is being continuously updated. This has been happening since the time of creation and will continue to the end of the Universe. In particular, we note that:

The process is not reversible[15]

The rate at which the updating occurs leads to our experience of time.[16]

A History is created for the Universe.[17]

Remembering the meaning of the term computationally irreducible previously explained, as the program proceeds, the Universe (which, as a whole, is computationally irreducible) evolves. Within that Universe, pockets of computational reducibility appear.[18]

These pockets that are computationally reducible represent the places where the current physical theories work and give us the engineering of our world. These regions exist within limits that are defined by many parameters: they may be complex, but can still be calculated with mathematical equations. As long as we operate within certain parameters, the engineering is possible: we can calculate things like the strength of bridges and aircraft because these are parts of the Universe that are computationally reducible.

Trying to extend beyond the limits, renders the engineering, impossible. Movements in the stock markets, fluid dynamics, and weather patterns are good examples. We can only model these aspects of our world using approximate mathematics and precision is simply not possible.

Conclusions

At times during the course of this essay I have considered that I might be suffering from a fit of hyperbole. It is true to say that Wolfram has not provided us with a recipe to create an eye or the taste of an orange.

In the short time that Wolfram has now been working on this model he has, however, successfully described the unification of gravitation with quantum theory, as well as a host of other major theories of physics that have proved intractable to conventional physics. He has an explanation for the missing mass and energy, something that on its own would constitute a major discovery. It has been exceptional progress in a very short time and Wolfram expects his model to resolve many other of the problems outlined in Part 1 of this paper.

Pleasingly, there are many points of agreement of this model with ideas proposed

13 Words by Stephen Wolfram.

14 It could be as short as 10^{-500} seconds.

15 This conclusion is consistent with the arguments in Part 1, i.e. that despite the predictions of mathematics, processes in the real Universe never go backwards, and that time travel into the past is impossible.

16 There remain some implications for time dilation and relativity that do not contradict Einstein's work, but which are outside of the scope of this essay.

17 This is a clear outcome of Wolfram's model that I have not found in his arguments, but which intimately agree with Unger and Smolin.

18 Gravity is computationally reducible, as is quantum theory. Black holes are not. Neither is the evolution of a human being.

by others who have suggested that traditional physics has lost its way and, as a casual observer, I would say that Wolfram's proposal can accommodate the main points of most authors. Even string theorists might find solace within.

What he has done is to show us how such extraordinary complexity can arise from simple ingredients. In the case of evolution the unimaginable complexity is seen to arise from comparatively few generations. This allows an entirely new insight into human evolution that has mystified so many of us for so long.

But with regard to the evolution of the entire Universe, Wolfram has shown us how previously intractable differences between theories can be resolved. This is surely a momentous occasion in the history of humankind.

Further Reading

I was never able to understand Einstein's Special Relativity theory. I have tried many times and failed. I promised myself I would never read it again as it was a waste of time for me. It concerns travelling fast in a railway carriage and being watched by someone in the field as you go by. Einstein says that the two people experience different scales of time. Now time is governed by the speed of light which never changes. And the speed of light is the same for both the man in the train and the man in the field. The maths was not hard, but I could never understand it in a deep sense. It all seemed so unreal. I have found the same with quantum physics. Having read Wolfram's work, the solutions have become so much clearer.

I have bought and read many science books in my life. Things have changed now so significantly that I shall never look at most of them again. The following books are those I intend to keep - some of them by my bedside for the foreseeable future.

Gleick, James: Chaos - Making a New Science. Viking Books (1987).

This was one of the early signs that mathematical approaches to solutions of nature's mysteries would not work. The book was very influential and nominated for a number of top awards.

Hofstadter, Douglas R: Godel, Escher, Bach: An Eternal Golden Braid. Vintage Books (1980). ISBN: 0-394-74502-7.

This book is very highly regarded as a work of great beauty and deep thinking. It was awarded the Pulitzer Prize.

Penrose, Roger: The Emperor's New Mind. Penguin (1991). ISBN 978-0-14-014534-6.

First published in 1989, this book was a very serious attempt to explain to a modern audience the problems of understanding the human brain in relation to modern scientific theory. With this exceptional book, Penrose began a series of works that have greatly advanced the subject, whilst leaving plenty of room for scepticism. It is an essential first-read for those unfamiliar with the subject.

Penrose, Roger: Cycles of Time - An Extraordinary New View of the Universe. Vintage Publishing (2010).ISBN: 978-0224080361.

Another remarkable essay from one of the world's greatest thinkers. This book uniquely proposes that the Universe was created from a predecessor and will itself lead to a successor Universe.

Penrose, Roger: Fashion, Faith, and Fantasy in the New Physics of the Universe. Princeton University Press (2017). ISBN: 978-0-691178530.

Once again, we find Penrose in the lead with solid arguments against some of the major arguments in physics that he considers are leading us nowhere. The problems posed by 'fashion' are easily summarised by those that affect us all - money, and the way it is dispensed by government. Human nature tells us that unbiased judgement is a rare commodity in the multi-billion dollar market place of science.

Stonier, Tom: Information and the Internal Structure of the Universe. Springer-Verlag (1990). ISBN 3-540-19599-8.

It is an unfortunate fact that Stonier seems to have received little credit for the substantial efforts he made in these three books of the 1990s to initiate new thinking about Information in the Universe. They have much to tell us.

Stonier, Tom: Beyond Information - The Natural History of Intelligence. Springer-Verlag (1992). ISBN: 3-540-19654-4.

Stonier, Tom: Information and Meaning - An Evolutionary Perspective. Springer (1997). ISBN: 3-540-76139-X.

Unger, Roberto Mangabeira, Lee Smolin: The Singular Universe and the Reality of Time: A Proposal in Natural Philosophy, Cambridge University Press (2014). ISBN: 978-1107074064.

Unger is a philosopher, and Smolin a theoretical physicist. The book is in two parts, the first by Unger. It was just as well because I'm sorry to say that I did not get far with Smolin's writings, although it was clear that they were in agreement. Unger's thesis was life-changing. In some of the most beautiful English prose I have read, he presents with absolute clarity many reasons why old physics needs to change. I was so impressed that the book has remained at my bedside ever since. As a non-Christian, I used it to replace Gideon's bible and I consider it my bed-time reading whenever I need emotional uplift. The book seems to me to have much common ground with my other heroes, Penrose and Wolfram, and it has been so satisfying to finally see a way forward past these dense problems of physics.

Wolfram, Stephen: A New Kind Of Science. Wolfram Media Inc., (2021). ISBN: 978-1-57955-025-7.

This book was first published in 2005 and has been updated in a new edition. Being a leading scientist, Wolfram publishes almost all of his work on-line and interested readers are encouraged to explore his work at several sites:

https://www.stephenwolfram.com
https://writings.stephenwolfram.com

Wolfram, Stephen: A Project to Find The Fundamental Theory Of Physics. Wolfram Media Inc., (2020). ISBN: 978-1-57955-035-6.

Both of these books by Wolfram are life-changing for, unlike Unger, whose thesis presents reasons to change, Wolfram's work shows how it can. I have never before seen relativity unified to quantum physics in just a few pages. Please read this book.