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The Gospel of Physics

My name is Jim Millar and I am by profession a teacher of Physics. In a recent B.B.C. science programme presenter Alan Davies said it was his worst nightmare to be stuck alone in a dark room with a physics teacher. Well don't panic. You are not alone today and room isn't dark..

Philosophically, as a religious naturalist, I am spiritually inspired by the natural world as revealed by modern science and despite the title of my address today, "The Gospel of Physics,"

I intend the word gospel to have its original Greek meaning of "good news" rather than its usual specific Christian context of good news about Jesus. Today I shall be proclaiming the good news about physics or more correctly, the good news about the universe as revealed by modern physics.

Physics is a relatively modern science. From its early beginnings in the Renaissance with the work of people like Copernicus whose radical discovery that the earth revolved around the sun marked the transition from the age of superstition to the age of science.

It developed rapidly in the Enlightenment with giants such as Newton. This period of classical physics, which defined a universe governed by a set of predictable laws, gave us a much better understanding of how the world worked and enabled the technical advances of the industrial revolution.

This world view of the classical physicist inevitably was at odds with the world view of the established church in the Christian West.

The concept of a theistic god who intervened actively in human affairs came under attack. Unable to reconcile this theistic god with the laws of physics, the god of Newton was a deistic god.

A god who created the universe like a cosmic watchmaker or in Masonic terms, a great architect of the universe, who intelligently designed the universe and set it running independently according to a set of laws.

This new understanding also helped fuel biblical criticism as the supernatural world view became challenged by a naturalistic one.

A more liberal view of Christianity and indeed in Germany of Judaism, emerged, but science was only just getting started.

Darwin's theory of Evolution by natural selection posed a serious challenge to what we understand it is to be a human and how we are connected to every other living thing on this planet. If this were not radical enough, at the start of the twentieth century we had two revolutionary new discoveries.

First was Einstein theory of relativity including his special theory, and following Maxwell's equations concerning electromagnetism, quantum theory. These we can refer to as heralding the shift from classical to modern physics.

In my opinion the implications of modern physics are not widely understood by people. There are many reasons for this.

First these ideas are relatively new. My grandfather was ten years old when Einstein published. My father was a toddler when Heisenberg published his uncertainty principle. It takes time for new ideas to become embedded. Certainly more than three or four generations.

Second, these theories are not taught at school. We teach classical physics at school and only scratch the surface of modern physics with the small number of students who undertake Advanced Higher in the Sixth form.

Third the theories are difficult to understand. They are dependent on an appreciation of mathematics beyond most of the population and often fly in the face of classical logic. The old Buddhist saying to know what Zen is, is to know nothing about it, could equally be applied to quantum mechanics.

So with this caveat in mind, to know is to know not, I hope today, albeit briefly, to look at some of the key ideas of modern physics, the new world view it presents, and since we are a spiritual people, the implications for our spiritual journeys.

I shall endeavour to keep things as simple as possible however if at any time you feel your head is about to explode please feel free to shout, "make the bad man stop".

Quantum Physics.

No Chinese who has been raised on I Ch'ing has ever found Quantum Physics puzzling. It is only puzzling to people raised on Aristotelian Logic where things are either A or not A. In the I Ch'ing things are either A or not A at the same time.

With quantum mechanics you can prove that light is made up of particles experimentally. You can build up a whole mathematical theory of light travelling as little particles called photons and you can do experiments showing that light is made up of particles. We've also got a whole mathematical theory built up showing that light travels as waves and we've got experiments that show you that light travels as waves.

As one physicist in the 1920's said it looks as if the light is waiting to see how were going do the experiment and then deciding which way it's going to travel. The modified Copenhagen View is that light is neither waves nor particles until we look and then it adjusts itself depending on what we are looking at it with.

An electron is not anywhere until we look and when we look it decides to be somewhere as long as were looking and as soon as we stop looking the electron is everywhere again.

Every model we make tells us how our mind works as much as it tells us about the universe. These are just human symbolic games. The universe itself is bigger than any of our models.

Relativity

The first topic I would like to explore this morning is relativity. We are all familiar with Einstein's famous equation $E=mc^2$, which tells us that mass, or matter if you prefer, is just a form of energy we don't fully understand. The fact that mass can be changed into pure energy is familiar to us in every nuclear power station and indeed the sun itself. However what came as a surprise to the scientific community is that nature has a speed limit. Nothing can travel faster than the speed of light about 300 thousand kilometres each second. This has some interesting implications.

The first of these, leaving out the mathematics, is time dilation. As you move time slows down for you. Honestly. For example consider 2 twins 29 years old. One leaves in a space ship and travels very fast through space returning one year later expecting to celebrate his 30th birthday with his twin. He is unaware that time has slowed down for him and is shocked to find his twin who stayed on earth is ready to celebrate his 70th birthday. To travel quickly is to travel forwards in time. Time is not a constant.

O.K. what about mass? We can rely on that surely? I'm afraid not. As you travel your mass increases. You have to put energy in to make something move and some of that gets converted to mass, so I'm afraid that mass is not constant.

What about length? A metre is a metre a foot is a foot surely?....

You know what's coming don't you. The faster you travel length contracts.

Space, time, mass, none of these things are constant. O.K on a day to day basis you don't notice any changes because we don't travel incredibly fast but the fact remains they change as you move and can be understood only relative to the speed of light, hence the term relativity.

The world is not as we necessarily perceive it.

Emptiness

The second idea I would like to explore is an idea familiar to anyone of you who has explored Buddhism. That of emptiness.

When we look at the billions of stars in the night sky we can get an idea of the empty universe. The nearest star to us, Proxima Centauri, is over 4 light years away. That means that even travelling at 300 thousand kilometres each second, the light has still taken over 4 years to reach us. And there is nothing in between.

However we are not usually aware of the emptiness of things around us. Our science teachers at school told us about the atom. A nucleus surrounded by electrons. But if the nucleus was the size of a football, the electron would be 20 miles away. Inner space is empty too.

Consider this tin of soup. It has a list of ingredients printed on the side. If a physicist had written it it would read "this tin contains 99.9999... that's 12 9's after the point, percent nothing."

What we see is an illusion. There's virtually nothing there. We can't see through it because light reflects off it into our eyes so it looks solid.

It feels solid only because the electromagnetic forces between the atoms in this object and the atoms in my hand are strong enough to stop my hand going through it.

It feels heavy only because of the force of gravity trying to pull it to the centre of the earth. Take it out into deep space and it will float weightless in front of you.

Everything around us, including you and I, are basically empty space. What we perceive is an illusion. A construct of our human minds. There is a large discrepancy between how we perceive reality and what reality actually is.

Quantum Mechanics

We have considered the big picture of the universe through relativity and the illusion of our day to day existence. Let's venture into the depths of the atom into the strange world of quantum mechanics.

The idea started with the discovery that light was not a continuous wave but came in little discreet particle like units which were called quanta. This explained why sometimes light seemed to act like a wave and at other times like a particle. However Young's double slit experiment seemed to suggest that matter for example an electron, also seemed to exhibit wave like properties.

We heard briefly in our readings earlier about what we physicists call "particle wave duality". The question was, is an electron a particle or is it a wave?

According to Schrodinger an electron is a smeared out wave. It doesn't exist in one place in space in time. It is a wave that permeates all space and time. In the Bohr Heisenberg model an electron is a particle like a tiny ball but there was a degree of uncertainty as to where the particle was. To understand where an electron is you have to look at it. That means shining light on it. The very act of shining light on it disturbs its location. The very act of observing the object changes its location. This is the measurement problem. An atom only appears in a particular place if you measure it. As Schrodinger commented,

A careful analysis of the process of observation in atomic physics has shown that the subatomic particles have no meaning as isolated entities, but can only be understood as interconnections between the preparation of an experiment and the subsequent measurement

What is more, the more we know where a particle is, the less we know about its speed, the more we know about its speed the less we can know about where it is. Physics joke. Heisenberg is stopped by a traffic cop. Do you know how fast you were going? he asks.. No officer, but I know exactly where I am.

It should be noted that this uncertainty is not due to any failure or limitation in our ability to measure. It is an inherent quality of matter itself. Einstein didn't like this. He famously said "*God doesn't play dice with the universe*". However it would appear that when it comes to particle physics, not only does god play dice, he is an inveterate gambler, and he sometimes throws them where they cant be seen. If a universe built on uncertainty which changes on interaction with a conscious observer isn't mind blowing enough, wait to you hear the next bit. One of the strange features of this world is quantum entanglement. When two particles interact with each other they become entangled, developing a special connected relationship with one another. If one of these particles is affected say by observation, the other particle will exhibit the same traits instantaneously no matter how far apart they are, or as Einstein called it "*spooky action at a distance*". By implication since all matter and energy started from a singularity at the big bang, it follows that all matter or energy that we experience now is and always has been interconnected.

String Theory

The big problem in Physics is that the world view of big physics as exemplified by Relativity and little physics as Quantum Mechanics are irreconcilable. They work on different mathematics.

In the 1970's in an attempt at reconciling these two world views, a new idea emerged. That of string theory.

Over two thousand years ago the Pythagorean philosophers in Greece discovered how music worked mathematically on stringed instruments. By vibrating a string at different frequencies one could produce different notes and these notes are linked

mathematically. A middle "C" is a vibration of 256 Hz. Double that frequency to 512Hz and you move up an octave to the next "C".

This idea was applied to the sub atomic world. Physicists proposed that when you get right down inside the atom as far as you can go, we find that everything is made up of vibrating strings.

An electron is a vibrating string as is a photon of light, the same thing just vibrating differently. When the maths was done it was realised that yes, the two models we had before could be reconciled. The Universe is a wonderful cosmic symphony. There was just one problem. To make it work we needed ten dimensions. Now we understand 4 dimensions. We understand up and down, left and right and forwards and backwards. We can also understand time, past, present and future as a fourth dimension. But ten dimensions? Hidden dimensions we cannot see or comprehend. To make matters worse, the latest version of string theory, M theory, calls not only for ten dimensions but for parallel universes.

Our universe is like a slice of bread standing cheek by jowl with others in a giant cosmic loaf.

Ten dimensions? Parallel universes? Even I'm ready to shout "make the bad man stop".

What Does It All Mean?

To examine what it all means I'd first like to share with you some words by the American Theoretical Physicist Michio Kaku,

In the beginning was the word, and the word was with god, and the word was god, and we physicists think that word was "the quantum." In the beginning was the quantum principle. There was nothing. But the quantum principle says that even nothing is unstable. Well if nothing is unstable bubbles form and rapidly expand. That is the big bang. Big bangs happen all the time in an ocean of nothing. We physicists are the only scientists who can say the word "god" and not blush. The way Einstein looked at it there are two kinds of gods. There is the god of prayer, the personal god, the god of Isaac and Moses and Jacob. However that's not the god that we physicists sometimes invoke.

There is also the god of harmony. The god that says there is a reason why things are the way they are. Why does it have to be so simple? Why does there have to be order rather than chaos? With string theory, we now believe the mind of god is music resonating through ten dimensional hyperspace.

I don't know about you but I find that idea really beautiful.

From my perspective the good news of physics is this. The universe more marvellous than we could ever imagine.

We humans are unique on this little far flung planet of ours in that as far as we know, we are the first creatures here which have evolved a brain capable of being able to comprehend it all.

We understand that our experience of space time which we call life is very precious and for each of us very different and unique.

The responsibility falls on us then to act accordingly.

The gospel of Physics challenges our dogmatism. In a universe where even space and time are not constant and has built in uncertainty, the idea that any political ideology, philosophical outlook or religious conviction must be true for all people

and for all time, is nonsense. Aye and dangerous nonsense too. In our society today as Martin Luther King put it, "*we have guided missiles and misguided men*".

The gospel of Physics challenges our intolerance. Einstein said, "*two things are infinite; the universe and human stupidity. And I'm not sure about the universe*". We are all prisoners of our central nervous system. It is the only interface with the universe we have to make some sense of this world illusion. But the constructs of our mind based on our own individual experience are unique. Different people not only have different opinions but actually experience space time differently from us and construct their own reality tunnels different from our own. Their reality tunnels are equally valid. We need to chill a little and value the differences between us, not use them as an excuse to persecute others.

The gospel of Physics challenges our materialism. Why strive after that bigger car that better suit when they are at end of the day 99.999, that's twelve 9's after the point, % nothing? Why not strive after things of real value, the love of our partners, the company of our friends, the laughter of our children? Do we really want to live in a world where we measure the worth of a human being strictly in material terms?

The Gospel of Physics comforts our sense of isolation. Quantum entanglement would seem to point to a true oneness in the universe. What was it the Buddha said, *All things appear and disappear because of the concurrence of causes and conditions. Nothing ever exists entirely alone; everything is in relation to everything else.*

The quantum field in which all matter arises is spread out throughout space and time and everything we experience is connected to a single interconnected source. And in our spiritual quest for that we call the divine, perhaps we should look not out there, in the incredibly large, but inside ourselves and in all others in the incredibly small. There we will find the god of harmony, the mind of god that is the music resonating the beat to this great cosmic dance.

Thank you for sharing the journey into my world.

Peace, love and harmony to you all.

Closing Words (Buddha)

He who experiences the unity of life sees his own Self in all beings, and all beings in his own Self, and looks on everything with an impartial eye.