PHYSICS MYSTERIES, PART TWO

Part One mainly discussed SR, but it is now time to turn to cosmology. I will though later return to relativity as well as venturing into quantum mechanics, or QM.

Gravity and the big bang

I don't know how many scientists should be credited with the idea of gravitational potential energy, but I wonder how, and where, they thought this energy was stored. If they had examined a falling body before and after it had lost some of this potential energy, what difference would they find? How would they know that some energy had been lost? They wouldn't have found any difference apart from a gain in kinetic energy. Whereas kinetic energy has demonstrable effects, e.g. the faster a cannonball flies the more damage it does, gravitational potential energy is just a theoretical idea. Once the important principle of energy conservation had been adopted, kinetic energy couldn't just appear from nowhere. An energy source had to be found.

However, if the inventors of gravitational potential energy had known what we know today, would they still have invented it? Knowing that a body's time rate reduces as its kinetic energy increases, would this not seem a likely energy source? Also, if the distance between two bodies is zero there is no potential energy between them and it is regarded as infinitely negative. Suppose the inventors had thought, as physicists now do, that everything started extremely close together in a big bang. Would this initial lack of gravitational potential energy have seemed a plausible source for the enormous kinetic energy of the swirling galaxies today? Or would part of process energy ($\frac{1}{2}mc^2$) seem more likely? When two asteroids are falling nearer each other they are said to lose gravitational potential energy, but their centre of mass attracts the rest of the universe with undiminished force (in fact SR predicts the mass and force will increase.) Yet this old idea of unmeasurable gravitational potential energy persists alongside the even older idea of relativity.

Although GR (general relativity) is a work of genius it predicts infinite density in black holes. Hence the laws of physics would break down. Infinite gravity and pressure mean infinite potential energy between atoms. This is avoided by the idea of constant space-time energy as an atom's potential energy remains finite.

When talking about the big bang we should start with the elementary observational facts. Since the time of the astronomer Hubble it has been established that the wavelengths of light from distant galaxies have been stretched. The further away the galaxies are, the greater tends to be the stretching. Wavelengths are stretched when a source and receiver of light are moving apart, so this suggests the universe is expanding. This means it was once much denser than it is now. If this expansion is projected back without limit it would arrive at a single point - the so-called big bang. All distances would have shrunk to zero and everything would be at a single point of infinite density. The laws of physics break down, but if the space-time energy of matter remains finite then this infinite density is again avoided.

(To avoid expansion altogether one might suppose that matter is getting smaller, hence distances only seem to get larger. In fact very old galaxies do look larger than less old ones, but this approach soon runs into difficulties which I will not elaborate.)

Physicists say that almost immediately after the universe started to expand, negative energy arose. As this was the opposite of normal energy it had a negative gravitational effect. This negative energy is said to have caused the universe to expand (or inflate) at a colossal speed - far faster than the speed of light. However, call me old fashioned, but I prefer to think that energy is conserved. If negative energy suddenly appeared (assuming this makes sense) I think an equal amount of positive energy ought to appear at the same time. The gravitational effects of the two energies ought then to have cancelled each other out. No doubt mathematical devices exist to justify this explanation, but having read about dividing zero mass by zero, I remain sceptical. I will suggest a different point of view shortly.

The emergence of matter in the early universe seems similar to the way it disappears into a black hole, but with time reversed. The intense gravitational field of a black hole means that matter falling into it experiences a time rate that reduces. The first particles after the big bang would have been very hot, so their speeds would have been very high and their time rate slower. As the universe expanded and cooled, the particles' speeds reduced and their time rates increased. So as I said, black holes and the big bang seem similar in opposite directions of time.

I think the big bang is one of the oddest aspects of cosmology. How did matter escape at high speed from the immense density of the big bang? Matter normally cannot help falling into much smaller accumulations of high density, e.g. black holes. Before addressing this issue, I need to make a couple of points.

Firstly, many physicists say matter will finally disintegrate into electrons, neutrinos and photons. Black holes would ultimately disappear through Hawking radiation. Secondly, the universe is dominated by gravity which is attractive in both directions of time. If a ball is filmed being thrown upwards, gravity still acts downwards if the film is run backwards. Gravity is a force not a process and it acts differently from a thermal process.

It is said everything arose in a gravity-defying instant, but I think we can equally say it arose gradually in an infinity of space and time. Particle interactions are time reversible, but *we* are driven along a single direction of time. (A reason for this is given later.) Consequently, and I know this sounds bizarre, we are seeing the contraction of the universe in reverse. As well as avoiding the miraculous escape from the big bang this seems to readily avoid other issues such as the so called flatness problem. In order to explain the current density of the universe its initial density had to lie within an improbably small range. This is often estimated to be within one part in 10^{62}. In the other time direction though the density simply increased from zero to its present value.

Time

Viewing time differently may seem ridiculous so I will go over the main points again and then add a few details. In the orthodox view everything arose in a single moment of time and accelerated away at colossal speeds against immense gravity. The relative expansion of the universe in a tiny fraction of a second was far more than in the billions of years since. This seems very odd. Ultimately, the contents of the universe are predicted to end up by de-materialising into simple particles and photons scattered through spacetime. As the universe expands it will continue to cool. Eventually it will be so cold that even black holes will evaporate and radiate away their accumulated energy.

It is extremely rare for stable particles to form from quantum fluctuations. This statistical rarity is less of a problem if particles form gradually over unlimited time and space rather than all in an instant. At this other end of time, and in the opposite direction, matter accumulates very slowly and becomes denser. This eventually leads to a big crunch that we call the big bang.

I am not saying we are viewing time in the wrong direction. Rather, we should view it in both directions. There is a logic to events that start with the big bang, but that does not exclude a logic to events that end with the big bang. Physicists of course treat the universe as four dimensional, time being regarded as the fourth dimension. If this is really true, the domains of before and after coexist as much as left and right do. A reverse direction of time is then no odder than other reversals of direction. We are processes that must move in one direction of time and find it difficult to see our time as a fixed dimension or place. We assume that the past determines the future, but the laws of physics do not support this one directional view. When a virtual photon leaves an electron, how does the electron know which way to move? This depends on whether the photon ends up at a positive, i.e. attractive particle, or negative repulsive one. This of course can be many years later.

The normal view of time allows us to make sense of everyday events, but it struggles with discoveries such as “spooky action at a distance”. In the usual time direction negative energy is said to suddenly inflate space faster than the speed of light for less than a millionth of a millionth of a millionth of a millionth of a millionth of a second and then abruptly become positive energy. I don’t think Mr Ockham would have been convinced.

The idea of cosmic inflation was devised partly to explain the universe’s early uniformity (varying by less than 1 in 1,000). Photons had insufficient time to even out energy fluctuations. This is called the horizon problem. The solution is that a microscopic region in which photons had harmonized energy differences suddenly became larger than the visible universe. Yet the detail in the cosmic background radiation still seems to require a huge number of random fluctuations to occur virtually simultaneously. This problem does not arise if innumerable fluctuations occurred over limitless time. The resulting particles can then accumulate gradually as the universe contracts.

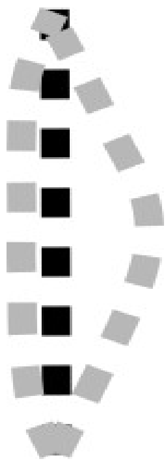
I have talked about opposite directions of time in relation to the big bang, and also about electrical charges somehow moving in opposite directions in time. Although I think there is no bigger mystery than that of time, it seems these two directions are not the same - i.e. there is more than one time dimension. Charged particles such as quarks exist in a mathematically ‘complex’ plane of time which has a mathematically ‘imaginary’ direction. This time dimension could be called hidden time. It is orthogonal to the ‘real’ time dimension that we experience and it augments the dimension that lies towards or away from the big bang.

This may seem to be a bizarre idea too far, so let me summarise. My main aim is to show that SR has been disproved. Freeing physics of SR’s spacetime leads to new ways to begin tackling the puzzles posed by the universe. The suggested second dimension of time is probably the most radical idea I will be suggesting. From now on I will try to explain these ideas more and show how they fit together.

Spacetime diagrams

I suggested that positive and negative particles, such as quarks, might move oppositely through a hidden time dimension. Yet we rely on neutral photons and are constrained to live in the time dimension of our thermal and living processes. Hence complex waves may move through an extra dimension and combine to meet in our four dimensional world of neutral photons. This of course implies there are at least five dimensions.

To see how this might work, we need to consider how energy in the form of photons and particles moves through spacetime. QM (quantum mechanics) predicts the probability of such a movement by combining all the ways it could happen. The adjacent diagram shows in black the shortest way that a wave could move vertically upwards, i.e. in a straight line. The grey line to the left shows another possible path. This is slightly longer and so this wave arrives slightly out of phase with the first one. To illustrate wave phases we can picture the crest of a wave created by a moving boat. If this meets the *trough* of an equally sized wave from another boat then when the two waves are added they give a wave height of zero - the waves have completely opposite phases. So for the grey wave to the left, and all others that are very close to the black one, their wave heights add up to give a large wave. This maximizes the probability that the wave will travel in a straight line. On the other hand the grey line to the right shows a path that is longer by about half a wavelength. This means it arrives out of phase with the first one. When all the possible zigzag paths are considered, the direct path has the greatest probability of occurring, i.e. it has the greatest number of paths that are approximately in phase. A longer path, such as the one on the right, has far fewer paths that are approximately in phase with it.



Adding phases also explains the refraction of light. This can occur when the speed of a light wave changes. If a wave enters a denser medium which slows it down, its frequency is unchanged but its wavelength is reduced. In general, the route having the most paths that are in phase will now be bent or curved. The principle that emerges from this is that light takes the quickest route, not necessarily the shortest one. This explains why light is bent by a glass lens and by variations in the density of air, e.g. in a mirage. Light bends so as to waste less time travelling through denser materials but travels a greater length through less dense materials where it moves more quickly. Hence light minimizes time loss. Minimizing time loss is a very important idea.

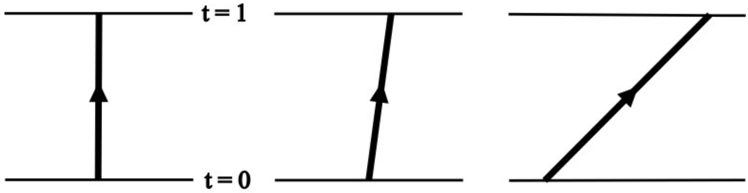
The dense matter in the early universe reached temperatures of millions of degrees. Thermal energy, like kinetic energy, involves matter moving quickly through space and slower through time. So in relation to our current time rate, process rates in the early universe were slower. Hence thermal processes can minimize time loss by moving directly away from the big bang. As we are thermal process this is also our direction of time. This seems a useful way to try to understand what is going on in the universe. Minimizing time loss along paths between the big bang and eternity also means matter becomes more stable. Potential energy distributes itself into motion energy (entropy increases) and this is radiated into an expanding space.

Photons can minimize time loss because different paths are available through space. If time is a plane then photons have an extra way to minimize time loss. Our time then functions as an extra dimension of space. This may be clearer if we consider an everyday thermal gradient. We experience this when we move away from a hot bonfire. Our ‘now’ is a particular distance along a thermal gradient in time. The heat from the big bang continues to drive our processes away from it at the speed of light. It also drives photons away from the past, but their energy, and hence overall speed, is undiminished by binding energy. So photons move faster and are able to catch us up.

The expansion of the universe seems to make more sense in reverse when galaxies fall toward each other. On a smaller scale though bodies within galaxies would fall away from each other. Yet as I said, gravity is attractive in both directions of time. It is photons that make the difference. Matter loses gravitational energy when kinetic energy becomes thermal energy and is radiated away as photons. Without these energy changes due to friction etc. bodies would remain in orbit, and falling apples would keep bouncing back off the ground. Photons move along thermal gradients in our direction of time even though the dominant cosmic force makes more sense in reverse, and cosmic expansion/contraction is basically frictionless.

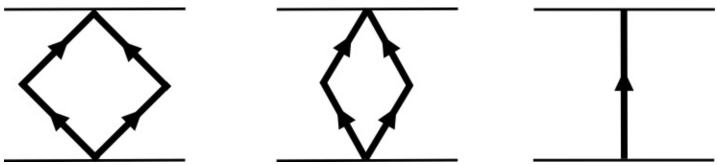
Despite the restrictions of a two dimensional page I now want to try to represent diagrammatically some features of an extra time dimension added to normal time and space. I will start with the conventional spacetime diagrams and then add diagrams to represent a second time dimension.

The normal spacetime diagram below on the left shows an object at rest moving vertically upwards through time. Its path through spacetime takes it from a time of zero seconds to a time of one second. Being at rest it does not move sideways through space to the left or right. The middle diagram shows an object that moves to the right over the same time period. The final diagram represents a body moving at virtually the speed of light. Such a path is normally drawn at 45 degrees. It is shown as moving through space as fast as it moves through time. Just to be clear, the lines show the final paths taken - not all the zigzagging components that are implied by QM.



For me, these diagrams do not help explain time dilation. If a moving particle's processes slow to nothing, where was it in spacetime when our world moved a second from the big bang?

Simple diagrams do not explain reality, but the diagram below on the left represents a stationary body in two dimensions of time. Normal time is again shown vertically, but the left-right axis now shows an extra time dimension. So these diagrams are at right angles to the previous ones. Waves from positive and negative directions move (sideways) at a speed of c. For simplicity their paths are shown as straight lines and they need to recombine in phase in our neutral world that moves (upwards) at a speed of c.



The square figure on the left represents a stationary body. The middle diagram shows a moving body and the final one a body moving at c. As a body's speed increases the square changes into a rhombus and then finally a straight line. But these diagrams don't show the spatial dimension of the conventional diagrams in which the path tilts from the vertical and gets longer. By combining both sets of diagrams the paths represented by the square, rhombus or straight line always have the same length between two different world times. This represents a constant space-time energy and a speed of light of $c\sqrt{2}$.

The midpoint of each path swings round in a circular arc as its speed increases. This arc reflects the way that the (Pythagorean) Lorentz time dilation factor affects bodies moving at high speed. If a body moved at the speed of light it would avoid the second time dimension and cease to age. So it seems this second dimension is the one in which time occurs and our four dimensions are where events are fixed.

Matter

The mystery of why matter exists can be split in two: why do dimensions exist and why do they contain matter? Unfortunately I do not have the answers. I can though use my ignorance and turn the first question round. Can I think of a reason to stop empty dimensions existing? The existence of extended nothing, as opposed to unextended nothing, seems to be a step towards something. However, the answer to my question is no, I am unaware of anything that would stop empty dimensions existing. Using my ignorance once again I can ask whether I can think of a reason why there should only be three dimensions of nothing. The answer again is clearly no. So whilst I don't know why anything exists, I equally don't know why an infinite number of empty dimensions of space would not exist.

It is possible to suppose that an infinity of empty dimensions is somehow equivalent to a few dimensions of things, by which I mean events, or rather relationships between dimensions. Physicists and mathematicians have shown that stable orbits are impossible in more than three dimensions of space. But this still leaves many questions. For a start, what are dimensions? I don't know. All I know is they are orthogonal to each other.

The simplest way to build a universe from an infinite supply of empty dimensions seems to be to bind dimensions together in some way. If these dimensions started out at right angles then binding energy represents a deviation from orthogonality. When a particle disintegrates, its constituents shoot off in different directions. Instead of the components' paths being aligned as the particle moves through space and time, they tend towards orthogonality. So orthogonality, on which the Lorentz factor is based, is obviously fundamental.

I will now consider the speed of light. A constant speed of light follows from the relativity principle of equivalent motion. As this principle has been invalidated by observations it follows that the speed of light is not constant for all observers.

Light

I will repeat an argument I used in *Part One* because I think it is important. The problem of the relativity of motion can be thought of as follows. Suppose an object moves at a velocity of v in my reference frame. This could be a car cruising at 60 mph with respect to the ground. How can this motion be related to a differently moving frame, e.g. a vehicle moving in the opposite direction? It is obvious that the relative speed between the car and every other differently moving object cannot be 60 mph.

This statement must be true for physical objects. Hence for a long time I thought SR must rely on the fact that light consists of many photons, and different photons from a light source can be absorbed by different objects. In principle it would be possible for individual photons or rays to strike each object at the same speed of c. Einstein's assumption could then be true, but not his other assumptions. Light emitters would need to know the future speeds of the light-absorbing objects before sending individual photons at exactly the right speeds. This either means causality is violated or else communication signals are sent between objects at unlimited speed. Having seen mention of "a ray" in Einstein's 1905 paper I see this is not what he meant.

I will now repurpose another argument from *Part One*. If the speed of light were constant for all observers, starlight ought to travel at different speeds through space to reach differently moving observers. The orbital speed of the Earth around the Sun is 30km a second or 0.01% of the speed of light. So, with reference to the Sun, light should travel 0.01% faster to reach the Earth when it is moving away from a supernova and 0.01% slower six months later when the Earth is moving towards it. This would ensure light hits the Earth at the same speed. For a supernova a million light years away the light's arrival times then differ by up to 200 years. (The relative speed of 0.01c is the same in each direction and SR's predicted time warp is invalid.) A delay of about 3 years also arises due to the Earth's spin.

Hence observations of distant events would keep repeating for observers at different times and places on the Earth, but evidently they don't. A distant flash of light arrives virtually simultaneously for observers on different sides of the Earth.

If we are to avoid astronomical events repeating themselves it seems the speed of light is not constant in relation to observers. Equally, it is not constant in relation to sources of light. If it were, this would lead to similar problems - not with supernovae but with orbiting binary stars. The following line of argument was produced by de Sitter in 1913:

When two stars orbit each other in the same plane as the observer their light would set off at different speeds through space. Light from the star that is approaching an observer would travel faster. Hence its light would reach the observer sooner than from the other (receding) star. The stars would then be seen to orbit each other in an irregular manner - yet astronomers see binary stars orbiting each other regularly.

There is a chink in this reasoning but it is generally accepted that the speed of light is not determined by emitting bodies. This argument using binary starts is similar to my argument about supernovae, but in reverse. However it is reasonable to say that if either two emitters or two observers are in relative motion, a single event can only be seen as such if the speed of light is independent of both the emitters and observers.

To avoid these problems it is natural to suppose that light is a disturbance of the electromagnetic field which arises from the quantum processes that underlie matter. As electromagnetic and gravitational effects diminish with the square of distance, the speed of light would be affected mainly by the motion of local matter, or rather its underlying quantum field. The speed of light from distant events such as a supernova would then keep changing depending on the motion of the galaxies along its path.

So the speed of light would be c in relation to the field where the photon is emitted and also c in relation to the field where it is absorbed. Hence a photon's speed can keep changing in relation to the particle that emitted it. If this speed increases, e.g. due to the expansion of the universe, the frequency reduces in order to conserve momentum. The conservation of momentum means that a photon's path appears to move sideways if it enters a gravitational field moving laterally in relation to its original path. This gives rise to stellar aberration. Light thereby moves through the universe at speeds determined by the gravitational fields it passes through. Light does not vary its speed merely to suit a moving observer who happens to get in its way.

If the field underlying matter provides the medium through which light moves, an observer moving through this field would experience different speeds of light. The relative speed of light reaching him from directly in front will be the sum of his speed plus the speed of light through the field. However, the faster he travels in relation to the local field, the more his clocks will slow down. This means it will seem to him he is travelling even faster. If the observer moved at almost the speed of light, his processes would almost stop so his speed would seem to be almost infinite. This of course contrasts with SR whereby two inertial observers will always measure the same relative speed between them and nothing changes their own clocks as far as they can tell.

Relativists often cite Michelson and Morley's experiment of 1887 (abbreviated to M-M) as proof that the speed of light is constant. M-M's apparatus could be rotated to measure the speed of light in different directions, but it was not rotated whilst observations were being made. Far less is said about the much larger Michelson and Gale experiment in 1925. This demonstrated the Sagnac effect that was first revealed in 1913 and showed that the speed of light is not constant. A modern version of the experiment is described later. M-M was not accurate enough to measure the inconstancy of the speed of light.

In order to explain M-M's results it seemed as if the Earth may contract in its direction of travel through an ether. However, the Earth's contraction due to motion through an ether seemed implausible. SR aimed to solve the plausibility problem by requiring the universe to contract instead of the Earth. It got rid of the need for the old ether by effectively giving observers and other photon absorbers their own individual ethers.

The speed of light is not constant, it varies with the strength of the gravitational field. For example, the light from other planets is delayed if its path is close to the Sun, i.e. when the planet is on the other side of the Sun from us. This is known as the Shapiro effect and it is attributed to the speed of light being slowed by the Sun's gravity, not by its atmosphere. It seems undeniable that gravity affects the speed of light, as predicted by GR.

One of the most important experiments involving the speed of light was carried out by Fizeau. He (and others) measured the speed of light through moving water. These measurements are important not least because SR was devised partly to explain them. Lorentz had previously put forward an explanation which, according to Einstein's book *Relativity*, was based on the electrodynamics of Maxwell-Lorentz. Einstein's described SR as "an outstandingly simple combination and generalisation of the hypotheses … on which electrodynamics was based."

Fizeau found that the speed of light through water, W, is:
$W = w + v(1 - 1/n^2)$ where w is its speed when the water is still, v is the speed of the moving water and $n = c/w$. Replacing n (the refractive index of water) we get $W = w + v(1 - w^2/c^2)$. If the water speed, v, could approach the speed of light, c, then W is nearly $w + c(1 - w^2/c^2) = w + c - w^2/c = c + w(1 - w/c)$. This is roughly $c + 0.2w$, so the speed of the light would exceed the speed of light. I assume the equation is not accurate at high water speeds. However, there seems to be a much simpler way to view Fizeau's result.

Light is a means of transferring kinetic energy. Although light slows down when it moves from air to water, this kinetic energy is not lost. We know this because light regains its original speed when it leaves the water. So it seems the water atoms carry some of the energy. Presumably the atoms fleetingly absorb some energy as they recoil in the direction of the light's travel.

The share of energy carried by the atoms is easily worked out. The energy of light through space is mc^2. When it enters still water this becomes mw^2 where w is its speed in the water. So the energy carried by the water is $mc^2 - mw^2$. After dividing by the total energy of mc^2 we find that the atom's share of the energy is $1 - w^2/c^2$. The atoms travel at a net speed of v, so the rate they transfer energy is $v(1 - w^2/c^2)$. To this we add the rate that photons transfer energy when they move at a speed of w in still water to give $w + v(1 - w^2/c^2)$, as Fizeau discovered.

One of the most commonly cited pieces of evidence in favour of SR is the behaviour of clocks on planes and satellites. The first experiment to test this was by Hafele and Keating. They carried atomic clocks on planes eastwards around the world and then compared them with atomic clocks that had stayed on the ground. The two sets of clocks were expected to behave differently for a number of reasons. For example the clocks on the planes are further from the centre of the Earth. So they experience less gravity and have a slightly faster time rate. As a result there are 'SR effects' on the clocks due to the clocks' relative speeds and there are the 'non-SR effects' due to differences in gravity and acceleration.

The non-SR effects are asymmetric. That is to say when an observer sees that a clock at a higher altitude has a faster time rate, an observer at this higher altitude sees a clock at the lower altitude has a slower rate. So observers can agree which clock is faster and which is slower. In contrast SR predicts that relative motion causes each person to see other clocks are slower than their own. So no one can say which clock is actually slower.

Physicists say that when the non-SR effects are excluded the Hafele-Keating experiment validates SR's predictions. So for ground based observers the airborne clocks were moving and should have lost time, which they did. However for Hafele and Keating on the plane it was the ground based clocks that were moving, so they should have lost time instead. In other words when the plane landed each set of clocks should have been slower than the other, which of course is impossible. There could only be one difference between the sets of clocks not two.

So the observation of a single time difference disproved SR. Relative motion does not lead to ground based clocks being slower as seen from planes or satellites. Westbound clocks are also found to run faster than ground based clocks. Yet SR only predicts moving clocks to be slower. To try to make sense of these results physicists use the Sagnac effect, but this also disproves SR - despite what relativists say.

An explanation of the Sagnac effect can be found on Wikipedia, but it can briefly be summarised as follows. Imagine bending a length of fibre optic cable into a loop. A light source is attached to both ends of the cable such that light can be sent in both directions around the loop at the same time. The light paths then meet and interfere in the detecting apparatus. A change in the interference pattern indicates a change in the way light has gone round in the two directions. If the loop rotates, i.e. in the plane of the loop, the patterns change; this is the Sagnac effect. (There is also a linear Sagnac effect in a "light conveyor").

Einstein said the speed of light is constant for an observer, or in this case, a light detector/interferometer. Hence the light paths should always be the same in both directions. This also follows from the general principle of relativity: motion is purely relative. Observers can regard themselves as being at rest and everything else as moving. Light should move at the same speed and frequency around the loop as if it is stationary and the universe is slowly rotating - and the reverse is true for the universe.

To see why the pattern changes one can look at the Theory section of Wikipedia's article. We need to be clear which reference frame is used. In the frame of the loop, the light path is the circumference of the loop. This is the same in both directions. It does not change if the loop rotates so there is no Sagnac effect. In contrast, in the Earth's reference frame the path lengths differ for the two directions. In one direction the length increases because the detector moves away as the light approaches it. It similarly decreases in the other direction so the interference pattern moves. The Sagnac equations are derived by assuming the loop is moving and c is measured in relation to the Earth's frame. So the speed of light is not constant in the frame of the measuring/observing apparatus, thereby disproving SR.

Light moves in relation to the field of the Earth. Yet this field has a fixed orientation with respect to the universe rather than rotating with the Earth. Imagine a point just above the Earth's surface on a line having a fixed direction from the Earth's centre toward a distant galaxy. The Earth's surface is then seen to move eastwards below it. The field associated with the rock below moves eastwards but the far side of the Earth moves in the opposite direction, and it seems these effects cancel. One may expect the nearer material to have more effect but evidently it doesn't. Electromagnetic effects diminish with distance in the same way that gravity does, and the nearer part of the Earth does not have a greater gravitational effect. Gravity acts through the Earth's centre not through a point nearer the surface.

The timing of GPS satellite clocks (which are in inertial free fall) is related to the Earth Centred Inertial reference frame which has a fixed direction in space. To explain clock rates we need to take account of the speed and kinetic energy of motion with respect to the Earth's centre. More kinetic energy means less process energy and a slower clock rate. Westbound clocks move eastwards slower than surface based clocks so they run faster, and eastbound clocks move eastwards faster than the eastward moving surface and so they run slower.

The Sagnac effect is used when calculating positions using GPS timing signals as these do not travel at a constant speed in relation to the Earth's surface. The Earth's surface is rotating in relation to its centre, so surface based observers see light travelling faster from the east and slower from the west. This comes as a shock for anyone who has been brought up in the shadow of Einstein. Less surprising is the difficulty of finding facts about Sagnac and GPS on the internet. There are the usual bland assurances that GPS validates SR, and there are sites saying the opposite, but official sites avoid explaining the use of the Sagnac effect to obtain correct GPS timings.

If the speed of light is not fixed for a laboratory, why did M-M (Michelson-Morley) find the speed of light was constant? M-M was designed to show that the Earth does not move through an ether that is fixed with respect to the Sun. M-M showed that any motion must be less than one sixth of the Earth's *orbital* speed around the Sun of about 30 km a second, i.e. 5 km/s. However, the Earth's *rotational* speed about its axis is less than 0.5 km/s.

Relativists say the Ives-Sitwell and Kennedy-Thorndike experiments validate SR within the Robertson-Mansouri-Sexl framework. This sounds intimidatingly clever, but the latter two wrote a paper in 1976 which said the CMBR "has shown that cosmologically a preferred system of reference does exist." This is very un-SR. A preferred reference system means the principle of relativity fails Einstein's test for it. Ives-Sitwell demonstrated asymmetric time dilation, and Ives believed his experiment disproved SR. Kennedy-Thorndike is a more recent attack on the defunct ether theory. This showed that the frame in which light moves does not move faster than 10 km/s in relation to the apparatus. Again this is not relevant to light moving faster from the east in relation to the Earth's surface by less than 0.5 km/s.

So the speed of light is not constant in relation either to its sources or, necessarily, its observers. Instead the speed is related to the fields it travels through.

Another problem with SR concerns causality. Consider for example the Moon orbiting the Earth. The equations describing this motion can predict the positions of these bodies in the future based on their current positions. Equally, their positions in the past can be estimated from their current positions. The equations work in both directions of time: there is a symmetrical connection between the past and the future. Yet SR assumes an asymmetry between emitters and absorbers of light in that photon speeds are fixed from the future. Photon speeds are determined by the future speeds of absorbing particles in order to get their relative speeds exactly right. This conflicts with the traditional direction of causality that was espoused by Einstein and which is also assumed in the rest of physics.

SR is said to have two postulates, i.e. the principle that all inertial motion is relative and that the speed of light is the same for inertial observers. It does though rest on an unspoken third assumption, namely that there is no single objective universe. This allows observers (and particles) to experience their own ether/space/universe through which their light moves. From their own world they are meant to find that objects in other worlds have differing masses etc.

This third postulate is so bizarre that it needs to be thoroughly verified, but physicists have not come up with any evidence showing that many realities exist. Moreover paradoxes show that these different realities are inconsistent. Physicists seem to assume SR is true because it is consistent with what is known as Minkowski space. Depending on which version of the Minkowski spacetime metric one uses, either distances or times are imaginary. However if an equation leads to a purely imaginary solution this shows it does not apply to the real world.

The Doppler Effect and SR

We are familiar with the changing pitch of a moving sound. The sound travels at a constant speed through still air irrespective of the speed of the sound source or of the listener. This is akin to the speed of light through the Earth's gravitational field.

A photon's energy equals its frequency, f, multiplied by a number h (Planck's constant), i.e. its energy is E = hf. If a light source approaches an observer at a moderate speed of v, the observed frequency of the light will increase. It becomes f(c+v)/c; this is the Doppler effect. Hence in the emitter's frame the photon's energy is E = hf and in the observer's frame E = hf(c+v)/c. These different energies can be converted to different momenta by dividing by c. The differences are problematic if light has a constant speed and all inertial frames are equal. By this I mean it is problematic for non-physicists. If one believes in SR and is untroubled by the non-conservation of energy and momentum then it is not a problem.

Instead of a photon colliding with a particle, imagine that a 2kg mass is about to collide head on with a 20kg mass at a relative speed of 10 metres/sec. In the rest frame of the 2kg object the total momentum is 20 x 10 = 200. For the 20kg object it is only 2 x 10 = 20. Different frames give different answers, but the momenta make sense when viewed from the centre of mass of both bodies. This of course is determined more by the larger mass than the smaller one. Yet SR assumes all inertial frames are equal irrespective of the mass they apply to. (It also ignores which frames have been accelerated.) The moral being - don't use SR to calculate a photon's momentum or kinetic energy.

The equation E = hf implies a photon's energy just depends on its frequency, but this view seems incomplete. Measurements of frequency (in cycles per second) require the frequency to exist for a non-zero time. Equally, measurements of wavelength involve a non-zero distance. The importance of this point should become clearer with the following example.

Suppose an observer moves through a gravitational field toward a stationary light source that emits a short pulse of light. The observer sees the wavelengths as shortened. This means they appear to occupy less distance in total. Equally, the cycles will seem to last less time, but so will their overall duration. So one cannot assume that the energy of light increases simply because its frequency increases. The time during which this energy is being transferred will be correspondingly reduced. Hence the energy overall seems to be unchanged.

So the normal view of Doppler-shifted photon energy seems incomplete. In addition, SR makes no distinction between frames when estimating kinetic energies. There is a further puzzle. Imagine an observer moving at a speed of v toward a light source. The frequency and energy of a photon increase by a factor of (c+v)/c = **1+v/c** in accordance with the Doppler and Planck equations. So the energy increases with speed, but kinetic energy, $\frac{1}{2}mv^2$, must increase with the square of the speed.

To try to tackle these difficulties I use the earlier idea that light has a speed through spacetime of c in addition to the speed of c that we measure through space (giving a resultant speed of $c\sqrt{2}$). If we add the impact energy from a measured impact speed of c+v to the photon's hidden kinetic energy we get $\frac{1}{2}m[(c+v)^2 + c^2] = m(c^2 + cv + v^2/2)$. To find the ratio of the impact energy to the photon's energy as measured in the emitter's frame we divide by mc^2. This gives **1+v/c**$+v^2/2c^2$. When v is relatively small the last term is negligible. Hence we get the linear relation between energy and speed that is found in Doppler measurements.

A photon has intrinsic energy as it moves through the local field. This is unchanged when seen by a moving observer despite the Doppler shift. It is the photon's impact energy at a relative speed of c+v that a moving observer experiences. In contrast, SR assumes the photon's speed is c in two differently moving frames and so gives different estimates of the photon's energy.

Relativists may be aghast at my use of a speed of light of c+v. Yet they accept c+v in the Doppler equation even though a relative speed cannot exceed c in SR. Adding c to v should be invalid for relativists just as dividing 0 by 0 is for non-relativists.

I ought to briefly mention the Pound-Rebka experiment which involved photons moving vertically between moving emitters or receivers. The idea was to find the speed at which a Doppler shift offsets the effect of gravity. The results support GR's time dilation equation, but this is also the equation derived at the end of *Part One* without GR's assumption of space being curved.

Light - a resumé

After a long section on light I will attempt a brief summary.

SR starts from two assumptions, or postulates. The first one concerning the principle of relativity was understandable up to the time it was disproved by Hubble's observations. The second and more important assumption is illogical, or perhaps I should say mystical, as it endows a beam of light with the ability to move at different speeds at the same time. Nevertheless this assumption became illogical after Sagnac disproved it.

Although relativists claim Sagnac supports SR, suppose the experimental outcome had been different. If Sagnac had found no effect, i.e. if the measured speed of light had been constant, would relativists then conclude that Einstein's assumed constant speed was wrong? Of course not, we humans are capable of ignoring experimental outcomes if they clash with our beliefs.

The consequences of light simultaneously moving at different speeds is that each object should simultaneously have different shapes, masses, time rates and time differences, but paradoxes and experiments show these effects are also false. The c+v and c-v terms in the Doppler equations are a strong clue that light moves in relation to a single local field, not each observer. This means we don't need to abandon the fundamental principles of conserving energy and momentum.

Dark energy

We are told that immediately after the big bang the universe's expansion was rapid, then it rapidly decelerated, then it expanded fairly constantly, then more quickly and now the expansion is slowing. Convinced? Stranger still is the explanation for the acceleration, i.e. dark energy. This unexplained negative energy is said to be constant per unit volume of space. So as the universe expands the amount of dark energy keeps increasing.

Most astronomical observations now seem to be well established despite the difficulties of estimating astronomical distances. As previously mentioned, Hubble found that light from distant objects was redshifted, i.e. its wavelengths were stretched. This effect increased approximately linearly with distance. So for two distant galaxies, if one were twice as far away then its light would be redshifted approximately twice as much. This linear relation implies a constant rate of expansion. However, technological improvements later allowed observations to be made of more distant galaxies. Hubble's linear relationship then seems to break. down. For a given distance, or rather estimated distance, the redshift is less than expected. This is interpreted as an accelerating expansion of the universe. This conclusion seems dubious when the underlying model of spacetime is wrong.

Very distant galaxies are receding from us much faster than the speed of light, but such speeds are not allowed by SR. So whilst 'proper' speeds can be faster than light, it is necessary to invent another type of speed. This is the actual relative speed of a galaxy minus the expansion speed of the universe at the galaxy's distance. Physics diagrams show the Hubble parameter for galactic recession speeds that are less than c, but for very high speeds they quote redshifts instead of speeds. So we can talk about a recession speed only up to the point where it is so high it has to be redefined as zero. Does this make sense?

Physicists say the space between galaxies is increasing rather than the galaxies are moving apart. So the measured relative speeds to galaxies need to be reduced by the relative speed of space, but if the speed of empty space is a scientifically valid idea then it should also be measurable. Yet measuring our speed in relation to space would clearly prove relativity to be wrong.

Astronomers say that redshifts due to expansion are not Doppler shifts (expansion speeds are not actually speeds). So SR requires two types of relative speed and two types of Doppler shift; but observations need only one. The problem of galaxies receding faster than light arises because SR defines speed in relation to observers. In absolutivity the speed of light is defined in relation to the local gravitational field. So the fields of galaxies can move apart without problems of infinite mass etc.

Dark energy is defined as negative, but I think energy involves the potential to do things. So energy should always be positive because zero energy means there is no potential to do anything. If the universe's energy is negative it should have the potential to do less than nothing. This makes no sense to me.

Dark energy is a term given to a mathematical symbol known as the cosmological constant which Einstein added to his GR equation to offset the cosmic effect of gravity. He wanted to model the apparently static universe. However it was shown that the constant did not produce the intended result. Any deviation from a uniform universe would continually increase and lead to a less homogenous universe than we see today. Einstein famously referred to the constant as his greatest blunder.

Einstein's constant was revived after Hubble found the universe is expanding. By varying the value of the constant, different rates of expansion can be modelled. In some models the so-called constant is allowed to vary to suit astronomical measurements. This is then called quintessence rather than dark energy. Yet attaching names to a mathematical symbol does not answer the question of what the symbol physically represents.

Dark energy is said to give space a negative pressure and this has a repulsive gravitational effect, but how can this cosmic pressure be less than zero? Negative pressure does not arise from matter such as dust, gas or plasma, and radiation pressure is positive.

Quantum effects lead to a kind of negative pressure between very close parallel plates, e.g. the Casimir effect, but galaxies are not close together. Also, in contrast to the Casimir effect, cosmic pressure is the same throughout the universe. I assume the pressure is not meant to be negative in relation to pressure outside the universe, wherever this may be, but I have yet to discover what the universe has less than nothing of. To delve deeper I need to talk about a cosmological equation named after its inventor Friedmann. This was derived from GR, but a derivation using Newtonian mechanics is often given.

This analyses the expansion of a universe having uniform density by considering the energy of a mass on the edge of a uniform sphere. The gravitational force on the mass depends on the sphere's radius and mass density. Newton found that the net gravitational force from outside the sphere would be zero if its density is spherically symmetrical. (The net force on a body in a uniform and infinite universe is zero - there being equal forces of attraction in all directions.)

This force is integrated to give the gravitational potential energy. For simplicity the constant of integration is ignored which means the potential energy is always negative. This negative energy is added to the kinetic energy of the small mass due to its radial motion to give its total energy (excluding its mass energy). The first law of thermodynamics is then used to equate the energy lost by an expanding fluid in the sphere to the energy gained by its surroundings, or in this case the rest of the universe. This energy is the change in the sphere's volume multiplied by the cosmic pressure. So it seems positive pressure (which should aid expansion) means energy crosses the sphere's surface (despite everywhere being the same) and this slows the expansion.

Hence negative cosmic pressure is used to explain any accelerating expansion. Thermodynamics is based on energy being conserved, but in the above it is used to arrive at a universe in which energy is not conserved. This seems logically unsound. There is also the problem of explaining what in the universe behaves like a fluid that sustains negative pressure.

Treating gravitational energy as negative, rather than as positive process energy, seems to have led to the idea that doing less than no work can accelerate the expansion. But negative energy seems no more plausible to me than a negative absolute temperature.

SR's equation for Doppler shifts gives a redshift of infinity for a recession speed of c but I don't know what adjustments are made to try to make sense of observations of very distant objects. Hence I don't know how the conclusion about an accelerating universe were reached. Needless to say I am not convinced.

Cosmological models predict the cosmic expansion speed should be 67.4 km/second/Mpc. Mpc stands for megaparsec which is a distance of 3.26 million light years. The latest measured figure (November 2025) is close to 70 km/sec/Mpc and the discrepancy from 67.4 is seen as a serious problem for current models. If the measured rate is simply projected back in time, i.e. ignoring any slowing due to gravity or acceleration due to dark energy, then the universe began 14.4 billion years ago. This of course is close to the currently estimated age of 13.8 billion years.

Although a lot of impressive science has gone into estimating the ages of cosmic objects, something seems wrong. Data from the James Webb Space Telescope indicate that galaxies and supermassive black holes existed much earlier than models predicted, i.e. when the universe was less than 3% of its estimated 14 billion year age. More head scratching now seems to be focussed on how these structures could form so quickly rather than on whether the age estimates are accurate.

Conservation of energy and momentum

The continual creation of dark energy is consistent with the view that energy is not conserved. However I am reluctant to abandon the conservation principles. I will now take the opportunity to discuss this further and to recap a little.

In the section on the Doppler shift I said a photon moving through a gravitational field has an intrinsic amount of energy. Suppose the photon's energy arises from a particular electron transition as measured in a laboratory at rest in the local field. Observers moving in relation to the photon source can then estimate their speeds in relation to the field by using their observed Doppler shifts. Observers who measure the 'at rest' transition frequency are themselves at rest with the field. So the field defines a preferred frame.

Evidence that the speed of light is fixed by the local field comes from the Sagnac effect as well as the non-repeating sightings of astronomical events. But even without observational evidence it would be very odd if disturbances of the electromagnetic field did not propagate in relation to the local electromagnetic field. How could light ignore the local field in favour of the far smaller field of a future observer or absorbing atom? Consequently I can only understand a belief in relativity from a historical perspective not a scientific one. I assume it stems from the time when boat decks were covered. Sailors below deck would have realised they had no way to judge the boat's speed, and this gave rise to the idea of the relativity of motion.

Physicists dismiss the importance of absolute amounts of energy and say only differences of energy are relevant. This view is consistent with the relativity of motion: the kinetic energy of the visible universe in SR can be different for each observer, so no credence can be given to the idea that energy is fixed. This emphasis on the relativity of energy seems to have led to the idea that negative energy corresponds to something that is real rather than just being mathematically convenient.

Gravitational potential energy is assumed to be zero when two bodies are infinitely far apart. This means energies are regarded as negative when bodies are finite distances apart. The adoption of negative energy, as opposed to the more useful idea of positive process energy, has probably led to the ready acceptance of negative dark energy. Its continual creation being just another step along the road of not conserving positive energy.

Instead of the ancient principle of relativity, motion can be defined in relation to the local field of a planet for example. In turn the absolute motion of a planet can be judged by reference to the CMBR. Hence there is nothing arbitrary about a body's kinetic energy. What though about the energy of light? Suppose a distant is receding at a speed of c. Photons from the star would need to double their speed to reach an observer at an impact speed of c. To conserve momentum the photons' mass would need to halve in order to compensate for the doubling in speed. (Halving the mass and energy corresponds to a doubling of the wavelength). Cosmological models assume that the loss of photon energy due to expansion significantly affected the expansion rate of the early universe. Yet reduced impact energy is not the same as energy lost from the universe.

In fact in the star's frame the photon's energy seems to have doubled from to $E = mc^2$ to $(½m)(2c)^2 = 2mc^2$ rather than being halved. Photons can gain speed from the expansion of the fields of which they are vibrations, so I do not see a need to abandon the principle of energy conservation. Kinetic energies arising from cosmic expansion seem problematic, and I do not know the relation between expansion and an extra dimension of time.

To keep the photon's speed constant in relation to an observer, SR requires the use of a 'stretching' co-ordinate system to cancel out cosmic expansion. It seems inconsistent to conclude that photons lose energy due to expansion if this view is based on a co-ordinate system that eliminates the expansion.

General relativity, GR

Absolutivity is based on the axiom that the universe as a whole is absolutely at rest. The universe is everything, so it cannot move in relation to itself. There is no basis outside the universe whereby its net motion could make any sense. Hence the principle of relativity makes no sense to me either.

GR is based on Einstein’s equivalence principle, i.e. acceleration is experimentally indistinguishable from a gravitational field. However, gravitational forces are directed toward a centre of mass and act radially whereas, for example, an acceleration in a space rocket does not. These differences are reduced in a region of space that is sufficiently small for radial and tidal effects to be insignificant, but it means GR is based on a local view of space. Moreover an accelerating observer could see changing Doppler shifts whereas a static observer in a gravitational field would not. (See also the *Equivalence principle* elsewhere on this website.)

GR very cleverly improved on Nordström’s theory that viewed the force of gravity as a distortion of spacetime. Yet other forces cannot be explained this way (hence GR is incompatible with QM) and it seems distance distortions have never actually been measured. If for example GR predicts space near an object to be stretched by 1% then measuring devices such as rulers should also be stretched, including the wavelength of light. Instead experiments to test GR measure the time light takes to travel between two points. Distances are then inferred from how many seconds elapse. However a second is defined by the local rate of an atomic process. If we could see a clock at rest where there is no gravity, its seconds would be slightly shorter and its time rate could define an absolute second. The use of varying seconds seems to conflate our time rate with the slower time rate in the early universe. This further complicates the issue of an acceleration of cosmic expansion.

When a beam of light bends slightly as it passes close to a star it seems obvious to say the beam has bent slightly. Light thereby travels faster along a slightly longer path in less time overall. As mentioned before, this is the standard way to explain the bending of light, e.g. through a glass lens or the atmosphere. In GR though, the light near a star is said to follow a straight path through a distorted space. However, a straight line is the *shortest* path between two points. So a light path cannot be used to define a straight line because light takes the *quickest* path. Mass distorts time rate but there seems no reason to say it distorts space. Space appears distorted if it is judged using curved light paths that are defined as straight.

A metre is defined as the distance light travels in 1/299 792 458 of a local second. GR predicts that time slows down as much as light does at any given location - which agrees with observations. This means that a metre is the same everywhere. For example, if the clock rate near a black hole were halved, and the speed of light were also halved, light would still travel the same distance in a local second. So if metres are the same everywhere, how can space be distorted, stretched or compressed?

GR is clearly an immense achievement. It does though follow on from SR which falsely predicts spatial contraction. Hence GR's predicted distance changes seem dubious. Gravitational waves (first predicted by Heaviside then Poincare) do not seem to involve objects moving near the speed of light in relation to each other. In which case SR's predictions play little part in interpreting the observations of these waves.

If distance distortions cannot be measured it seems GR could be recast using a model of spacetime whereby a plane of time is distorted instead of space. (GR is expressed in a mathematical way that is independent of coordinate systems.) Curved light paths could then be seen as being curved instead of defined as straight.

Quantum Mechanics, QM

The aspect of QM mathematics that is closest to the real world of three dimensional space and time is Schrödinger's equation. This describes the behaviour of waves in a manner reminiscent of the way the classical heat equation describes the behaviour of temperatures in a piece of metal for example. However Schrödinger's equation uses complex numbers. These have two parts that are called real and imaginary, e.g. 0.8 +0.3i. Whereas 0.8 is a normal real number, 0.3 is multiplied by i which equals √-1. There is of course no real number whose square is -1.

A particle's wavefunction, involves a summation or a superposition of complex waves. The 'size' of the wave is called a probability amplitude. Waves don't represent anything as simple as temperature, and QM doesn't say what the waves do represent but it does provide a way to convert them into probabilities. This is referred to as 'absolute squaring'. In the previous example 0.8 +0.3i would be multiplied by 0.8 -0.3i where the imaginary part now has the opposite sign. This produces a real number which is the probability of an outcome such as finding an electron in a particular region.

A wavefunction behaves in a way that Newton or any classical scientist would approve of i.e. it is completely deterministic. If the wavefunction of a particle is known then its future can be predicted with certainty - but only up to the time when absolute squaring leaves us with probabilities. A particle's definite wavefunction can spread very far and wide in space but then a particle suddenly appears somewhere. This is referred to as the collapse of the wavefunction.

This raises a number of questions. If human observers are in a definite state, what separates us from the quantum states? Where is the line to be drawn between our real world and the weird quantum world of superpositions? Or if humans are also mixtures of states, why can't we reliably predict the future?

Physicists cannot agree whether a wavefunction collapse represents a change in the real world or even if collapses occur. Nor is QM clear about when wavefunctions should collapse. Originally this was when a physicist made a measurement or an observation (so it wasn't clear how particles existed without physicists). Many other ideas have since been put forward. In the GRW theory the wavefunction of an individual electron or proton only collapses every 100 million years or so, but Roger Penrose has proposed that collapses are instead linked to gravity in order that QM can be made compatible with general relativity.

Before considering this further I'll mention the way QM treats a particle's spin direction. If the north end of a normal magnetic axis points up this is obviously at 180 degrees to the direction in which it points down: an "up" vector is the opposite of a "down" vector. Yet in QM the state vectors for spin "up" and "down" are orthogonal to each other, i.e. at 90 degrees. This halving of the actual angle makes the subject far more difficult.

The direction of a particle's spin axis is often measured using a Stern-Gerlach, or SG, device. This is basically a small tunnel through which particles can be sent. It has a magnetic pole at the top and a more concentrated opposite pole below (i.e. the poles are at 180 degrees not 90). Suppose a particle passes through a SG device and is deflected upwards. It then enters a second device tilted sideways at an angle A to the first one. The probability of being deflected up again is ½cos(A) + ½ or equivalently $\cos^2(½A)$ where cos stands for cosine. So I assume QM uses the half angle ½A as this involves squaring the cosine - thereby making it consistent with absolute squaring. (Some spin directions in QM involve complex numbers so ordinary squaring would not work.) Yet spin orientation is conserved, unlike a particle's position, so it seems strange to depart so far from directional reality to use the same methodology for spin. Moreover when calculating the effect of tilting a normal sized magnet the tilt angle isn't halved. Surely geometry doesn't change at some scale as atomic sizes are approached.

Suppose two particles have opposite but unknown directions of spin and one particle is deflected upwards by a SG device. One may think its spin axis initially pointed somewhere in the upward hemisphere and the SG device aligned it directly upwards. Yet orthodox QM denies the existence of any direction until a measurement is made. This makes it awkward to explain how the direction of the second particle can be correctly predicted. Einstein and others argued from this that there was something wrong with QM. A signal would need to be sent from the first measurement to the second to ensure the spins are opposite - as the law of spin conservation requires - but this would mean physical effects sometimes travel faster than the speed of light.

Experiments have led to the conclusion that effects do travel faster than light. This should be impossible if it takes energy (i.e. mass) to change the second particle's axis to a direction in which its magnetic potential energy is not minimized. However I think quantum processes also occur in an extra time dimension. So particles have unknown spin components in this dimension and a random particle has a 50% chance of its axis being up or down when it appears in our time. By random particle I mean its spin axis has not been fixed by a SG or other device.

Suppose an up spin axis is represented by a normal unit vector, i.e. it has a magnitude of 1. The vector's component at an angle A is then cos(A), e.g. a down spin is cos(180) = -1. This is a knowable real vector, but it only tells us half the story from one of the two time dimensions. If we scale cos(A) by ½, giving ½cos(A), we can add the hidden effect of the 50% probability from the extra dimension to arrive at the earlier formula of ½cos(A) + ½. This is a far less convoluted approach to calculating the overall probabilities of a particle's interaction with a second SG device and the unknown vector component this involves. Before returning to the wavefunction collapse problem I should stress there is more to particle spin than the cosine formula, but the above suggests a simpler approach is possible.

Although orthodoxy no longer requires a measurement in order to collapse a wavefunction the issue is still referred to as the measurement problem. A rapid or instantaneous collapse implies simultaneity but this is forbidden for distant events by SR. This is a particular problem for the pilot wave theories that take the radical approach of avoiding the troublesome collapses of the wavefunction as well as the randomness of the universe.

A more popular view of QM (maybe because it is said to be consistent with SR) is the many worlds interpretation or MWI. This avoids the ‘quantum versus real’ split by assuming wave functions do not collapse. Instead the different quantum states become real states. Schrödinger’s cat becomes zillions of cats, some dead and some alive, each somehow in a separate world. Each particle splits when it has approximately “decohered” and the world we experience is said to be continually splitting into a mind boggling number of slightly different worlds.

Suppose an atom with a long half life has a chance of one in a zillion of decaying in any given instant. To allow for this a new world containing a decayed atom should arise every instant. If the universe splits into two worlds each time, one with an intact atom and one not, the chances of an observer finding an intact atom would quickly decline and the half life would be too short. So presumably a zillion worlds with intact atoms are created each instant for every world with a decayed atom. What is the mechanism for creating these worlds, and where are they?

If the total energy of the universe doesn’t grow at a stupendous rate, the energy density of each new world should be shrinking. Based on the current energy density of our world, the density of each early world should be vastly greater than now. This ought to lead to an observably different expansion of the universe. Alternatively the mass/energy of the total universe is growing at a humungous and exponential rate. This seems to be a spectacular example of abandoning the principle of conserving energy without any evidence that this principle is invalid.

Double slit experiments

Given the apparent relevance of another time dimension to **q**uantum mechanics I will start to refer to it as '**q**-time'. I can then use **r**-time for our **r**eal time and also use **s** to refer to a dimension of **s**pace. Conventional spacetime diagrams depict an rs plane. I also showed the qr plane. Normal spacetime uses the rs^3 space whereas I am using the five dimensions of qrs^3.

There is no end to the things I fail to understand due to a lack of knowledge or intelligence. What really troubles me though are mysteries which seem to lack a rational explanation, such as the sudden appearance of the universe, its rapid expansion and the predictability of its 'random' processes. I still don't understand spacetime, but q-time seems to be an idea in the right direction. In particular the weird rules of quantum mechanics, and their reliance on complex numbers, seem potentially understandable in qrs^3 space rather than within the limits of rs^3 space. It may be objected that an extra dimension is unverifiable, but then so are the many extra dimensions of string theories. Ideas need to be judged by their utility rather than just how tangible they are - wavefunctions being a good example.

The idea of q-time arose from the principle of space-time energy. This relates speed through space to speed through time. The latter is a ratio between different times and this makes more sense in terms of a second time dimension. These ideas are all based on energy, but what is energy? It seems to arise from coherent vibrations of spacetime, whatever this is, and energy conservation implies the waves never die out. They either move through spacetime in the form of photons or else they recur as standing waves in particles which move less quickly. As the earlier section on the Doppler shift shows, a moving observer can measure a shift in wave frequency, but observers do not change a body's energy or the universe's total vibrational energy. Moreover it seems unlikely that the vibrations terminate at the big bang. What could absorb these vibrations?

I will now briefly discuss the most famous experiment that demonstrates quantum wave effects. This involves electrons (or atoms) being sent from a point source toward a barrier having two holes in it. The electrons can be sent one at a time. The holes take the form of two narrow parallel slits. Detectors on the other side of the barrier record where the electrons arrive.

Although an object such as a bullet would travel in a straight line through one of the slits, a single electron is likely to arrive midway between the two slits. After many electrons have been detected it seems each one passes through both slits as a wave. Midway between the slits, the wave from each slit travels the same distance. Hence the wave paths here are the same; they are in phase which increases the chance that an electron will appear here. At other positions the wave paths will differ so the waves can cancel each other out. This interference of 'matter waves' results in most of the electrons being detected in symmetrical parallel bands on either side of the midpoint. These bands do not occur if one of the slits is closed (but some interference can occur depending on the size of the opening).

This raises the question of how the energy of a particle, or even a large object such as a car, moves through spacetime. One approach is to think how traffic gets from one part of a city to another in the morning rush hour. If the paths of all the vehicles were known we could see that most of them take a direct route. Others though make detours, e.g. to visit shops or schools etc. The analogy would be a bit better if some vehicles zigzagged around the world as well as changing briefly into different types of vehicle and travelled backwards and forwards in time at different speeds - including those much faster than the speed limit. This would reflect the fact that all the possible ways of moving through spacetime are combined in the maths of QM. It would though still ignore the wave-like nature of matter and the fact that there is more to matter than we can observe.

QM involves adding and multiplying complex vectors that represent waves. Each path that energy takes, and each bit of each path, is represented by one of these vectors. When wave paths can cancel each other, the vectors are added. When paths are not alternatives to each other they are multiplied. This is not very difficult in principle, but as the number of paths is infinite it can be very complicated to combine them all accurately.

We can ignore these complications by just trying to imagine a photon going from A to B and then from B to C. This can be represented by two vectors named AB and BC. The overall vector from A to C, called AC, can be calculated by multiplying vectors AB and BC. This makes sense in terms of probabilities. The probability of a photon going from A to B and then to C is the probability of going from A to B multiplied by the probability of going from B to C. The overall probability will also diminish for paths that continue from C to point D.

Now suppose there are two different ways to go from A to D. The original route is ABCD, but in addition there is now AXD, i.e. going from A to X to D. If the probability of going along ABCD is unchanged, we might think of the route AXD as a bypass route. This second route changes the overall probability of a particle going from A to D, e.g. when an electron can travel through two slits rather than one. In the traffic analogy the bypass adds to the roads' capacity for traffic to flow from A to D. In QM the two vectors representing the two different routes are also added. However, as the vectors represent waves which can be out of phase with each other, adding vectors may well reduce the overall probability of energy going from A to D. This corresponds to fewer electrons arriving at an out of phase point when its energy passes through two slits.

The result of multiplying and adding vectors is a final vector which in general has a non-real or imaginary component. This of course needs to be 'squared' to produce a real probability for each of the possible manifestations of a particle in rs^3.

Non-real numbers of course do not correspond to anything we see in our rs^3 world, yet physicists say the rules of complex numbers are essential in QM. This seems to provide strong evidence in favour of an extra 'non-real' dimension, as does the ability of waves to explore the universe in no time - or rather no r-time.

The non-real components of the waves have opposite signs, or phases, implying they move in opposite directions in q-time as depicted on page 9. They seem to have an energy through q-time (of ħ/2) which means the energy or lifetime of a particle in r-time is uncertain. These different q-time components need to cancel out for the waves to appear in rs^3 and produce neutral photons from which we infer the existence of particles.

The wavelength, λ, of a body's matter wave varies inversely with its momentum, p, i.e. $\lambda=h/p=h/m\mathbf{v}$. This equation came from the idea that energy divided by c gives momentum, $p=E/\mathbf{c}$. This is odd as a body's actual speed of v not c is used to get from energy to momentum. It is less odd if bodies have a speed of c through spacetime. If matter wave energy at a speed of v comes from the total unbound energy of mc^2 it would be $E=mv^2$. In general $\lambda=v/f$. So from $E=hf$, $\lambda=hv/E=hv/mv^2=h/mv$ as required.

Vectors in QM are multiplied if they are sequential parts of the same path, so absolute squaring using opposite signs suggests events are sequentially linked in opposite directions of q-time. Hence our notion of causality based on r-time is insufficient to explain QM. Similarly, QM represent states by using an extra dimension that lies beyond our senses and instruments, so events seem to be random because of our lack of knowledge. We don't need to speak of possibilities collapsing when dice stop rolling.

In QM particles have negative kinetic energy when they are "quantum tunnelling", but how can $\frac{1}{2}mv^2$ possibly be negative? This seems less odd if waves move in q-time where time and hence speed lie along the i and -i directions. As $i^2 = (-i)^2 = -1$ v^2 can be negative. (Imaginary numbers are of course removed in absolute squaring and particles are never found to have $v^2 < 0$.)

I now want to look at a detail of QM that involves matter waves.

The wavelength of matter waves depends on what physicists call action (which I'll try to explain later) and something called a Lagrangian. In the book *Classical Mechanics* by the renown physicists Leonard Susskind he says "Why are all systems described by action principles and Lagrangians? It's not easy to say but the reason is very closely related to the quantum origins of classical physics. It is also related to the conservation of energy." Yet the Lagrangian does not conserve energy which is the sum of kinetic and potential energy.

Susskind gives an equation, Eq. 1, for the Lagrangian containing the term T – V, i.e. kinetic energy *minus* potential energy. He says "You might think there is a typo in Eq. (1). Energy is the sum of T and V, but the integral involves the difference. Why the difference and not the sum? You can try the derivation with T + V but you'll get the wrong answer." He says candidly "Sometimes the Lagrangian is guessed on the basis of some theoretical principles or prejudices, and sometimes we deduce it from experiments."

To understand the meaning of action imagine a body is moving from A to B. The Lagrangian at any point is the kinetic energy minus the potential energy. Suppose you multiply the value of the body's Lagrangian by the time this value exists and you do this for every bit of the path from A to B. The sum of these products is the action (i.e. the line integral of the Lagrangian over time). The path that the body takes from A to B is the one that minimizes the action. This provides a powerful insight into how to solve many problems and is known as Hamilton's principle. But why does our world obey this principle?

If energy is conserved then the sum of kinetic and potential energy is constant. I'll express this as KE + PE = C. From this we get KE = C - PE. The Lagrangian is KE – PE, i.e. C - 2PE. So minimizing action means maximizing PE or process energy over time. This is the same principle of minimizing time loss that guides our arrow of time, as described on page 7.

EPR and Bell's theorem

In 1935 Einstein, Podolsky and Rosen (EPR) proposed an experiment involving a nuclear decay whereby two identical particles are sent in opposite directions. The position of one particle is measured as accurately as possible, so according to QM its momentum is unknown. The momentum of the second particle is then accurately measured. Assuming symmetry, or the conservation of momentum, the positions and momenta of both particles can now be deduced. This violates Heisenberg's uncertainty principle, so something seems wrong with QM.

The second measurement could be made just after the first and far away from it. So if the first measurement affects the second its effect must be able to travel faster than light - which was thought impossible. So there should be local hidden variables that explain particle behaviour. But most physicists were content with the "shut up and calculate" approach. QM gave the right answers and it was useless to ask how to make sense of it.

In 1951 Bohm suggested a different way to distinguish between faster than light effects and hidden local variables. This used entangled particles having opposite spins. Bell developed this in 1964 into a statistical test (it's too involved to go into here) which physicists now use to say there are no hidden variables.

Imagine spin up particles from a SG device are sent through a second device tilted by 1 degree and a few down spins emerge. As well as the original r-time vector there is a possibility that the second device adds a q-time vector that is *within* 1 degree of the new downwards. This would be closer to being down in the second device than the r-time vector is to being up, so the resultant spin vector is down. The probability of this varies with the size of the circular solid angle in which the q-time vector needs to point, i.e. ½cos(A) + ½ where A is measured from up. As this simple local model seems to explain the experimental results I don't to see why they disprove non-locality.

Black holes

It seems John Mitchell was the first to use Newtonian gravity (in 1783) to predict the existence of stars so massive that light could not escape. Einstein did not accept black holes existed in reality. Maybe he thought god would ban objects in which such a beautiful theory failed. GR predicts ‘singularities’ of infinite density where information seems to end along with physics. This is a problem as QM requires the information to survive.

The diagrams on page 9 suggest a way to represent time dilation due to speed, but what about gravitational dilation? I suggested waves move in opposite directions or phases through hidden time, or q-time, as well as through real spacetime, rs^3. In strong gravity, the waves having opposite signs in q-time might become closer. If paths through qrs^3 still have the same length, the effect is to shrink spacetime diagrams along q-time and stretch them along r-time. The vectors for particles then have smaller q-time components and so are time dilated. The vectors for photons still have no q-time component, but their s^3 component is shorter so their speed through rs^3 is reduced. This way of viewing the effects of gravity on the speeds of both time and light is consistent with the idea of finite space-time energy, and it seems a way of avoiding the singularities predicted by GR.

Why is the universe suited to life?

If the values of nature’s constants were formed at random it is extremely unlikely that stable atoms, stars and life would form; but there is no reason to assume the universe is random.

Matter is predicted to disintegrate in the part of the universe most distant from the big bang, but in the reverse direction of time the evolution of matter is akin to survival of the fittest. Only the most stable relationships between fundamental entities (empty dimensions?) persist as atoms. I don’t know why gravity exists but as it requires atoms to clump together in clouds, stars etc. I don’t find I need to resort to the anthropic idea that life is required in order to be conscious of the universe’s existence.

Finally

There is a logical way to begin thinking about the universe, i.e. it cannot move in relation to itself. It has no net momentum. This principle gives us Newton's laws, e.g. reactions are equal and opposite. These laws conserve zero momentum as well as conserving energy. This in turn gives us the foundation of physical science. The motion of observers cannot change this, and thinking otherwise is the root of all evil in physics.

A belief that effects cannot travel faster than light has obscured the determinism that underlies the universe. Chance does not explain nature's precise and predictive laws but our ignorance of another dimension does. Nothing plays dice with the universe.

It is natural to assume that the universe only exists in the instant of our awareness. We do not apprehend how quantum effects move faster than light. Yet it seems that process energy drives us in just one direction of time. This is *our* arrow of time, not a law governing all the processes in the universe.

Any antimatter is soon destroyed in collisions with matter, but physicists think the big bang had equal amounts of matter and antimatter. This leads to the question of what happened to all the antimatter. If energy and matter are vibrations of spacetime that are not absorbed then on the other side of the big bang may lie a universe of antimatter. Perhaps some of its inhabitants are also wondering what became of *their* antimatter.

I have suggested a number of ways to free physics of SR's absurdities. These may themselves seem absurd as they involve odd ideas about light, time and causality, but then so does SR. As far as I know though my oddities do not seem to have been disproved by experiments whereas SR has. If I find that any of these ideas is wrong I can enjoy trying thinking of new ones. This is a benefit of applying the scientific method to physics.