“A flexible cylinder to model physical functions of consciousness”

"Consciousness from a physicist’s point of view. From the physics of information to the two functions of consciousness: recording the present and configuring the future"

Origin: A lecture delivered at the “Institut de France” in Paris on 5th December 2012 by Philippe Guillemant, researcher at CNRS, as part of the colloquium on "Birth, emergence and appearances of consciousness" organised by François Gros, Perpetual Honorary Secretary of the Academy of Sciences, François Terré, honorary doctor at law, member of the Academy of Moral and Political Sciences and Bérénice Tournafond, President of the "Being Human" Society.

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Abstract: We consider the universe as entirely described by physical information and we propose to describe its evolution as a variation of its information, as if it were calculated by a giant computer implementing the laws of nature. However, a delicate aspect of this process is that nature contains a certain amount of indeterminism, something demonstrated by quantum mechanics. We interpret it as a lack of physical information and we show that many chaotic or dispersive macroscopic systems could also loose information. In such a context, where information about reality could be not only lacking locally but also automatically lost, that is to say turned into macroscopic quantum states, we propose that consciousness could have two functions: firstly, recording new information in the universe in the present, in the form of classical states; and secondly, configuring information about the future as probabilities of events, meaning that there is a coexistence of multiple branches of events within a Multiverse. Though a choice seems to be made by consciousness in the present among various possibilities, we show that this choice is not a result of free will because it depends on an already realized immediate future, with respect to the first function of consciousness, which is purely deterministic recording. We propose that free will could be obtained via the second function of consciousness, which is to modify probabilities in the future, by means of external information that could come via extra dimensions. We show that this mechanism for configuring future information could explain coincidences and synchronicity, involving retrocausality. We finally choose a flexible cylinder as a very simple reduced model to describe the effect of both functions of consciousness on our individual path of life and the effect of extra dimensions on the form and orientation of the cylindrical path towards the future.

1. Introduction

Good morning, I am very honoured to be here with you all today. I am a physics engineer conducting research at the National Center of Scientific Research (CNRS) on the subject of physics information. This has been an emerging field ever since physics began giving an objective meaning to information, something we can sum up as comparing the universe to a giant computer. This approach will allow us to improve our understanding of the fundamental role played by consciousness. It is a question of finding out what sort of relationship the universe has with consciousness, to what extent it exists outside consciousness and what role this plays in the structure of the universe. As you will have seen from the subtitle of this conference, I have already made an immediate reply to the question regarding my own point of view about consciousness: "*recording the present and configuring the future*". In fact, there is no general point of view on this subject among physicists, because they tend to avoid it altogether, expressing only personal views. My own view is, I admit it, an original one: stating that consciousness records the present and configures the future may appear disturbing, so before I start, let me make things a little clearer.

What I am talking about is a recording INSIDE the universe and a configuration OF the universe. Yes, that does mean that the universe needs our consciousness as an interface for acquiring information, for here we will consider that the universe is a universe of information. But let me reassure those of you who are attached to an objective conception of reality. My viewpoint is one that sustains such a concept, that is to say, of a universe actually existing outside ourselves, a material universe where causality plays a fundamental role, except that this universe is not entirely structured. Certain pieces of information are missing, which is why those of you with spiritualist leanings will also find it interesting. I have to say, though, that it is highly likely that consciousness doesn't actually structure anything most of the time, that the universe is already structured and that everything happens as if reality were independent of us. Nevertheless, we will develop the premise that this is not always the case, or to put it another way, that the universe is only partially configured, something that quantum mechanics already shows us to be true.

2. Inverting received wisdom on key concepts of Time and Information

Another key concept, besides information, is fundamental for gaining a better understanding of consciousness, and this is the concept of time. In my presentation, I will be talking essentially about time and information, and I will quote three famous men: Einstein, Nietzsche and Bergson, to help you understand why it is interesting to link the three of them together:

In a letter to his friend Besso, just before his death, Einstein wrote:

"*People like us, who believe in physics, know that the distinction between past, present and future is only a stubbornly persistent illusion*."

Such absence of distinction means that the past, present and future are simultaneous or in some way contained in the present. It begs the question whether this implies that the future might already be realised. Nietzsche wrote about this, in "*Human, all too human*":

"*Our destiny exercises its influence over us even when, as yet, we have not learned its nature: it is our future that lays down the law of our today.*"

The following phrase is also attributed to him, and it helps us understand:

"*The future influences the present just as much as the past.*"

Astonishing, don't you think? In any case, it has the advantage of being even clearer than Einstein. Above all, it is extremely awkward, because if we are determined simultaneously by our past and our future, it is difficult to see how we could retain any free will. Free will, therefore, would be just an illusion. Bergson rebelled against this determinist idea and wrote in "The possible and the real":

"*What is time for? Could it be the vehicle of creation and of choice? Doesn't the existence of time prove that there is indetermination in things?*"

At first glance, this is in total contradiction to the two previous quotes. Indeed, it is hard to see how indetermination could be reconciled with double determination coming both from the future and from the past. But what is indetermination, in fact? Well, we will simply interpret it as a lack of information, which is why information, like time, will be a key concept during this lecture. And what we are going to do will end up turning our received wisdom about time and information completely on its head.

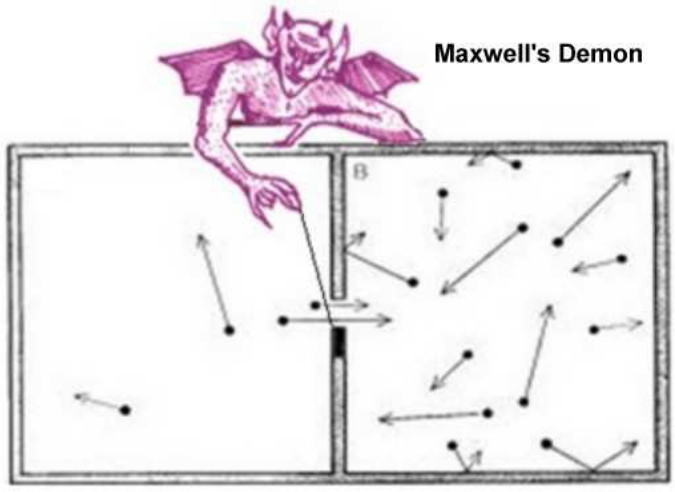
Here is a brief glimpse:

Often, we believe that time is something objective, because it is the variable "t" in physics equations. We will see that this might not be true, that time might just be subjective, because time and the variable "t" can be eliminated from physics equations.

As far as information is concerned, we usually think it is subjective because it is relative to the person that possesses it. We will see that, on the contrary, information is a concept in physics that is starting to be seen as objective, or in other words, information is in the process of becoming an actual measurement in physics.

3. Information: a new measurement in physics

Where does the idea come from that information might be an actual physical measurement? Strangely enough, it comes from traditional mechanics, thermodynamics to be more precise, a science quite as odd as quantum mechanics, although not many people know that. Everyone thinks that traditional mechanics is not odd because we believe that it is determinist, and yet the idea that traditional mechanics is determinist is at the root of an open-ended problem that first emerged 140 years ago, and still hasn't been resolved: we are talking about the thought experiment known as Maxwell's Demon.



Take a container full of gas with a wall dividing it into two compartments. A small opening allows for communication between the two compartments, meaning that the gas is at the same pressure on

each side of the wall. But now imagine an apparatus capable of shutting the opening every time a molecule arrives from the left compartment and of opening it every time a molecule comes from the right: now a difference in pressure is created, and the apparatus can even create a vacuum on the left side. Maxwell's Demon is a metaphor for such an apparatus, which uses little or no energy at all, since all it has to do is open or close a sliding door with possibly negligible mass. This means that the Demon could manufacture mechanical energy simply by using the information it has about the position of molecules! This would mean that we had something capable of creating free energy! Which means that there is an acute risk that information could actually violate the laws of physics!

Today, we have managed to exorcise the demon by saying that information necessarily has a minimal cost in terms of energy equal to k T ln(2), where T is the temperature and k ln(2) is a quantum corresponding to 1 bit of information. k is Boltzman's constant, something in the region of 10^{-23}, a tiny number. Introducing 1 bit of information thus reduces the entropy by necessarily introducing energy. This means that entropy is quite simply the opposite of information.

When the demon acquires information, it consumes some of the energy related to the necessity of observing a molecule, which means that no energy is free; and vice versa - when the system loses information, it dissipates energy. This is called Landauer's principle, verified in experiments carried out last year, in 2012, by physicists from the Ecole Normale Supérieure in Lyon.

For all that, not everybody really agrees yet about this correspondence between energy and information. For a start, we can doubt the necessity for the demon to need to observe the gas molecules in order to know their position, since according to determinism, this can be calculated. Therefore determinism has a problem with the correspondence between energy and information. Wanting to preserve it makes things very complicated, and in order to clarify the debate, we could say that there are two points of view:

Either we preserve determinism within a determinist framework by solving the problem that appears to make information dependent on the observer, the person who possesses it, so as not to have a subjective production of entropy or energy, which would be quite unthinkable! Some physicists believe that they have found a way to solve this problem by linking information to algorithmic complexity. Now this isn't my cup of tea at all, and frankly I find it quite impossible to digest, but it is still one possible way out for anyone unwilling to adhere at once to my way of talking, although I must point out that quicksands lurk in this direction.

Or, we consider that information is one of the universe's genuine physical measurements but that it is limited everywhere to a certain number of bits because of the quantum of information, since the energy in a system is always finite. The problem here is that systems like this one – mixtures – eventually lose all their information as they become mixed and become indeterminist; in other words, even the universe itself no longer knows where the molecules are, just like in quantum mechanics. This is something I have verified for myself by calculation, through my work with billiards, something we will say more about later.

Classical physicists find it hard to accept this idea. And yet, all we are doing is finding the same result as in quantum mechanics. We think that observed reality isn't quantum because when we observe it, it appears to be determinist. But maybe the observer restitutes information through the act of observing. It may well be that, as a complement to what we call the decoherence process, it is the observer that redetermines reality in the end, just like in quantum mechanics.

4. Quantum mechanics and information

What happens in quantum mechanics? It too has a problem with information, because of the

superposition of states and the famous observer paradox that reduces all states to one single state. You must have heard of Young's double-slit experiment in which photons are sent through one by one and we find that they pass through both slits at once, because they continue producing interference. Except, that is, when we observe them, in which case they only go through one of the slits. So as long as we don't observe them, they take every path at once. This is because the information on the path taken by the photons simply does not exist before observation. In fact, today we know that the result of observation is completely indeterminist, that is to say, it is not the result of the past.

This was proved in 1982 by Alain Aspect, in his experiment on twin particles. It proved that quantum mechanics was right and Einstein wrong when he said that God didn't play dice. In fact, it would seem that He does just that, in fact, because when you observe something, everything happens as if the universe were drawing a straw to decide what you would see, as if it were creating reality at that very moment. Einstein, though, didn't agree about this drawing of straws, and said that there had to be hidden variables, whereas Alain Aspect proved that there aren't, or at least, no local hidden variables. There is still a possibility that Einstein was actually right, but only if the hidden variables are non-local, or in other words that they violate causality, and indeed, we will see that this is in fact the case. Having said that, the concept of "non-locality" contradicts Einstein's relativity while at the same time being fully verified today, for it is the consequence of a phenomenon we are now well-acquainted with: quantum intrication.

This intrication is the second oddity of quantum mechanics. Einstein called it long-distance phantom action, that is, communication between two points in space where the signal travels faster than the speed of light, something that runs counter to the theory of relativity. In reality, there is no phantom action, and we will have to get used to the idea of intrication because it has been proved over and over again and constitutes the technology on which future quantum computers are based. Intrication is simply due to the fact that when superposed states of two particles are correlated to their origin, the correlation subsists whatever the distance between them, otherwise the mechanics of their paths would be incoherent once it had been observed, so it isn't as mysterious as all that. It is just an illusion of strangeness that comes from the fact that we cannot stop ourselves from reasoning in ordinary time, that is, from separating the moment of observation from the moment the correlation occurred.

There are other strange things in quantum mechanics, like its apparent retrocausality (or retrocausation). I say "apparent" because this is something certain people still have trouble accepting, but once again, it is because we reason in ordinary time. This is the delayed choice quantum eraser experiment that occurs with intricated photons. The result of the experiment is that everything happens as if intricated photons were capable of adjusting their past according to the future choice of a researcher in switching a detector on or off. Astonishing, isn't it? You yourself can create a part of the universe's past by looking up at a starry sky and receiving an intricated photon. This is what makes Stephen Hawking say that it is the observer who creates reality and that this creation travels back in time, which of course is true, as long as the universe isn't already informed about the past. This is what he calls top-down cosmology. Careful, though - Stephen Hawking remains a convinced determinist, a partisan of the theory of what are called non-local hidden variables, or variables from an unknown source. Roger Penrose does not agree with this at all, because he thinks consciousness intervenes in the process of state reduction: broadly speaking, it isn't God who's playing dice, but consciousness, in an orchestrated manner in the brain. This is his Orch'OR model, and we will come back to it later, but you can see that here, too, Penrose introduces information from an unknown source, because that is precisely what indeterminist chance is.

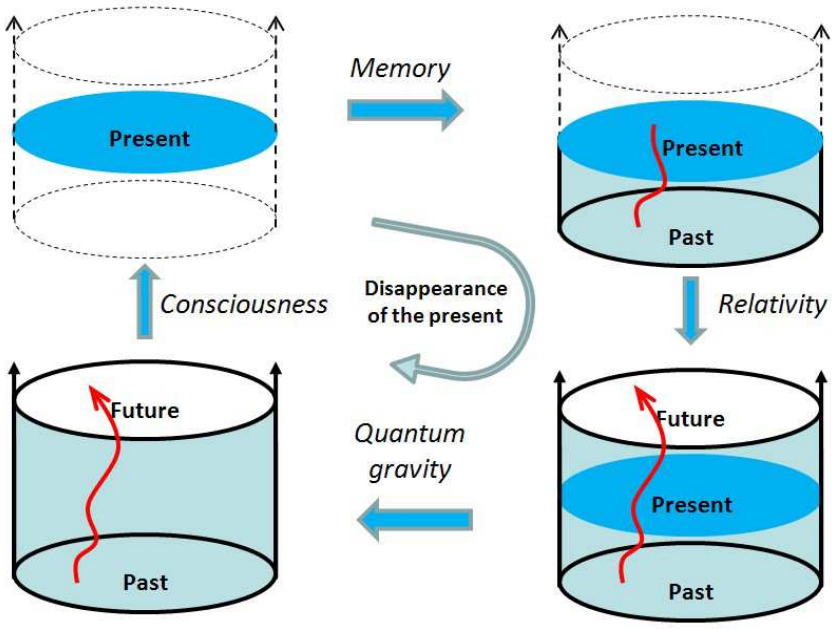
What we can say about quantum mechanics, then, is that in every case, it uses information that

determines reality but comes from nowhere, what I call foreign information: either non local hidden variables, or information with a non causal influence over the present – outside the cone of light, for the connoisseurs among you – or else information resulting from an indeterminist chance event: in other words, God playing dice with wave function collapse. You have to admit that, for an exact science, this is pretty bizarre. But be careful: the main problem with all this is that the foreign information that determines what we observe is supposed to arrive in the present at the moment of observation.

Now we have a problem – because physics is in the process of eliminating the present from its equations!

5. Reality is not created in the present!

Physics has a problem with the present because of Einstein's equations and relativity. No present exists that is common to us all. If two people in the same place are both travelling, so that one of them is going much faster than the other, then this is enough to make them disagree about the present. Hardly moving at all relative to one another, but simply being very far away from each other, will also be enough to make them disagree. This is why Einstein introduced the model of the block universe, a model I show here represented by a cylinder. The circular section of the cylinder represents a disc corresponding to two dimensions of space rather than three, while the length of the cylinder represents time. The disc replaces a sphere meant to contain the entire universe. This way, the cylindrical representation includes all of space-time, from the past to the future. So we already have grounds for doubting the question of whether reality is created in the present.



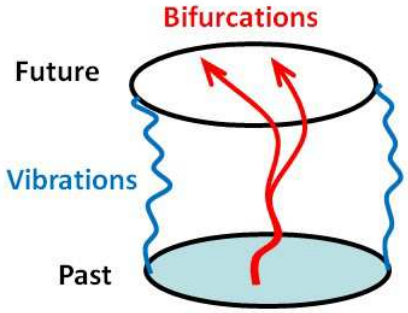
Obviously this runs counter to normal intuition, for we are accustomed to think that the future does not yet exist. As far as the past is concerned, we aren't entirely sure, but we want to believe that it still exists. According to Einstein's vision, however, we see that the future is treated like the past, meaning that it is quite possible that the future already exists. Since we cannot trust the present, everything occurs as if it didn't actually exist, a fact confirmed by the theory of loop quantum gravity. This is a very powerful theory, because it reconciles relativity and quantum mechanics, which is the main problem in physics today. It eliminates time from physics equations, in other words the variable t representing the present. And when the present disappears, we have a problem: how does the universe evolve?

Maybe it doesn't evolve at all, in which case everything, including everything we will live through, has already been created. Einstein didn't really believe this, which is why he spent his whole life searching for a theory of grand unification, but in vain. Now, what can we do to rediscover our liberty in a space where our life is fixed? I have illustrated this using the red temporal arrow representing our destiny. In four-dimensional space-time, this line cannot move. But maybe there is a solution to make it move?

Carlo Rovelli, one of the two progenitors of loop quantum gravity, thinks that the block-universe can move, but not in the present. He wrote: "We have to learn to think of the world, not in terms of something that evolves in time, but in another way." Now that is exactly what we are going to try to do, bearing in mind that Carlo Rovelli made Space-Time vibrate.

6. A solution: making Space-Time vibrate

So here we are, I've portrayed several of these temporal lines bottom right, with a horizontal bar representing the present, except that now we know the universe cannot evolve any further in the present. The question, then, is this: if we made Space-Time vibrate, couldn't we make all the lines evolve?



Apparently not, because quantum gravity only makes Space-Time vibrate at an infinitely small quantum level, completely undetectable at our own. But we're forgetting something very important here: sensibility to initial conditions, or chaos! Using calculations, as we will see later, I have personally verified that infinitely small vibrations at a quantum level can definitely generate chaos, especially bifurcations capable of creating a considerable number of evolutionary variants at a macroscopic level.

In which case, whatever we were set to experience would already be realised, but susceptible to constant modification! Now you can imagine that the universe evolves everywhere in time at once, simultaneously in the future and the present.

Now, is that reasonable? In any case, mathematically, yes, it's possible, all you have to do is add a fifth dimension. Kaluza and Klein were the first to put forward the idea of a fifth dimension as much as a century ago, and it was something Einstein looked on favourably. It is a very tiny dimension rolled in upon itself. To imagine it, you have to tell yourself that instead of moving along a line, you keep circling round it. This is how we can regain our freedom, and it is by no means a false hope, because today's theories of grand unification also offer us this possibility. Let’s take a closer look.

7. Grand unification theories add foreign information (extra dimensions)

The main theories of grand unification are string theory and loop quantum gravity theory, both of

which appear at first glance to be completely incompatible, tending to imply that one of them must be wrong. But in fact, we will see that they have a great deal in common. To start with, we only have to point out that one of them maintains an immobile space, here represented by the shape of a tree where every branch forms a cylinder of the universe, while the other one makes space vibrate. The difference between them resides in their mathematical approach, but in the end you will see that the two theories are in fact complementary. Instead of making space move, string theory introduces 6 or 7 extra dimensions to space, which in the end amounts to the same thing. On the one hand, you have an elementary particle, the quark, for example, vibrating in the extra dimensions of space. On the other hand you have the same particle also vibrating, because it is space itself that is vibrating. As a result, the theory that makes space vibrate has no need to add spatial dimensions. However, it doesn't have enough dimensions to fully describe reality. It merely describes a stochastic, probabilistic reality. When the quantum fluctuations of space are transformed into real observations, then there is always a reduction of state into a single reality that is not described. Because of this, the future as described by loop quantum gravity is one that potentially contains multiple possibilities, just like the future as described by string theory, what we call the multiverse. We don't see it as quantum gravity because it is a dynamic approach that doesn't describe everything, whereas in the case of the multiverse of string theory we are dealing with a static approach that describes everything, but contains too many degrees of freedom.

Now, to marry these two theories, all we have to do is observe that the quantum fluctuations of the first may very well be responsible for the changes from one branch to another in the second.

The problem is that Stephen Hawking said nothing about all that. He said that we only live on one branch of the multiverse, but the thing is, he has no proof. In fact, there are 10 to the power of 500 possibilities of varying the vibrations of strings, and living on one single branch of the multiverse would mean that this vibration was always the same: there is no reason here, it is quite arbitrary. If you look at loop theory, quantum fluctuations can make us change futures in a completely random manner, so you see that chance can make us change branches. So if you reconcile the two theories, you have to reject Hawking's idea that we only live on one branch of the multiverse even though there are myriad others. And it is better that way, because the consequence of Hawking's theory is that it forces us to think that we all have billions of conscious lives in parallel universes. Personally, I cannot imagine that. There is a much simpler solution. All you have to do is confront those famous sources of foreign information that the other theories put in, whether they be hidden variables, chance or extra dimensions. Alain Connes, our own great mathematician, also adds spatial dimensions to space to reconcile the two theories of grand unification: yet again, additional information from foreign sources, as if, at every point in space, physics needs complementary information in order to predict the course of events, although no one yet understands where this information comes from!

So now we can ask ourselves this: why don't we use this sort of complementary information or extra dimensions in classical mechanics, at our own level?

8. Classical mechanics doesn't work well in 3D

In fact, this sort of additional information would be very useful in classical mechanics, because if we do a little exploring we come to see that mechanics actually works very badly in three dimensions. Or at least it does if we start from the point of view that information holds real physical meaning, implying that the entire universe has to be quantified. We encounter this quantification in loop quantum gravity that requires the universe to be discrete or of granular structure: this would imply the existence of indivisible grains of space, but also of energy, impulse, time etc. and in the end the universe would be like the picture on a television, not actually continuous but made up of pixels. Or if you prefer, the universe would contain an enormous but

limited quantity of gigabytes, like some enormous computer.

All this has consequences at a macroscopic level because the indeterminism that comes from quantification can then rapidly spread to the macroscopic level, which is what I am working on.

The first consequence of a granular space structure is that classical mechanics becomes indeterminist in three dimensions, as we have already seen with Maxwell's demon. This is what I have been able to demonstrate with calculations using billiards. Here is an animation (see http://www.youtube.com/watch?v=uc5NTFrqIPU) that illustrates how, after a certain amount of time in three dimensions, mechanics ceases functioning. I take two superposed billiards with the same initial conditions, except for one infinitesimally small difference between them, in this case a difference of 10^{-15}, and look how quickly it happens: as you can see, the two billiards swiftly diverge. Mechanics doesn't know where to go anymore. This is because it has lost practically all its information concerning the balls. I have been able to show that this happens even if the initial conditions differ by one mere grain of space - a non-existent, meaningless value. In that case, using 500 balls, it only takes about thirty collisions per ball for mechanics to stop functioning, and when you increase the number of balls, it takes even fewer collisions, actually tending towards zero the nearer one gets to infinity.

But that's not all, because I have also confirmed that even if space does not have a granular structure and can thus be as precise as we like, we still have an enormous problem with information, this being that when you calculate the trajectories of all the balls for as long as mechanics functions, you use a certain amount of memory to stock the entire evolution you have calculated. But after a certain number of balls, this quantity of memory becomes inferior to the memory required for the initial conditions. For a mechanical physicist, this represents something utterly aberrant: the fact that his model uses more information than it actually calculates. I have called this the paradox of classical information, or the demon of determinism. This means that as soon as we admit that information has a physical meaning, mechanics won't function in three-dimensional space, or at least not for very long, even if that space is continuous.

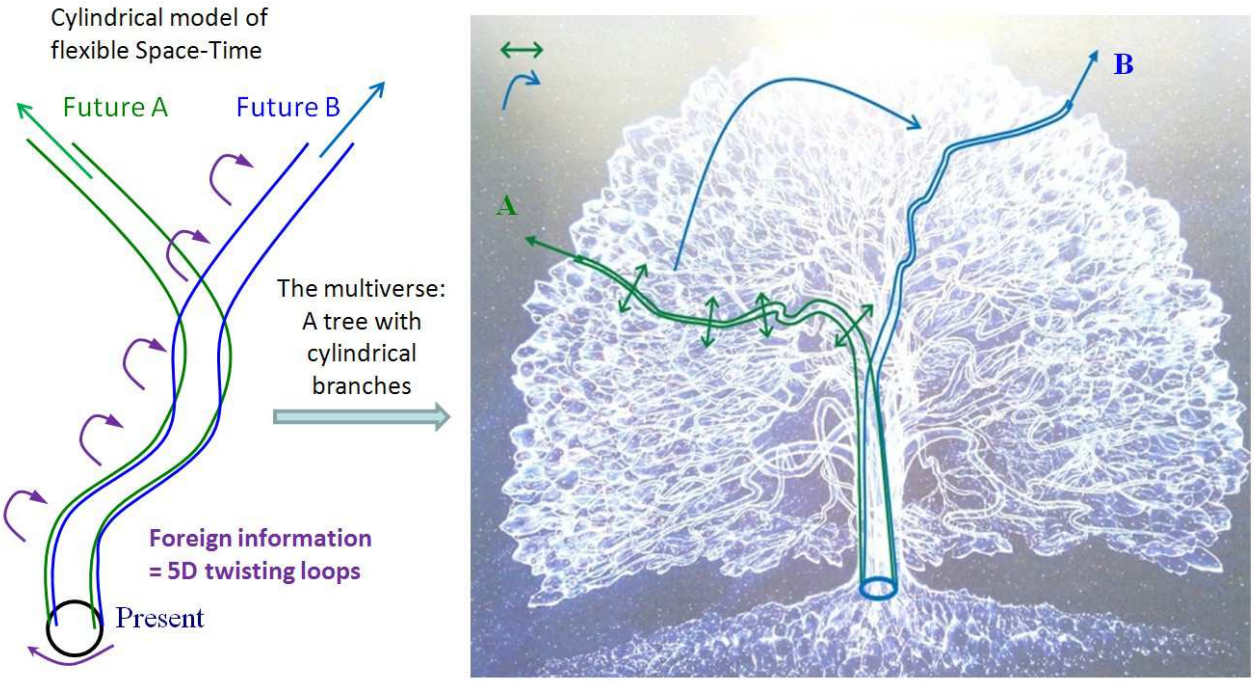
This is all very awkward. To restore determinism - something we have to do because we inhabit a single reality - I have therefore tried to add foreign information to allow us to choose the direction of events. For the moment, though, I'm having a little trouble with the technical choices I need to make to get it right, and spending more time on the presentation of what I have explained to you. There is something else, however: the smaller the balls are, the sooner indeterminism sets in on the billiard game, and in any other interactive system, even if we are not dealing with elastic collisions. Now this might well explain the quantum behaviour of particles at a lower level. For my part, the more I study mechanics, the less I see a difference between the classical and the quantum world, since indeterminism, observer interaction and even intrication are, to my mind, imposed by both kinds of physics. Personally, I have good reason to think that there is no frontier between the two, but I won't be insisting on this point, as I haven't yet established sufficient confirmation for my premise.

What we need to keep in mind here is that, yet again, we see that in order to calculate the future, it is indispensable to introduce foreign information to physics - except of course if we leave it to chance, by calculating the most probable future. The problem is that we're dealing with classical mechanics, something we don't often suspect of odd behaviour; yet the only way to introduce such information is to add at least one dimension to space, making five in all. This is nothing new, it's an idea we're starting to get used to, and something interesting happens every time someone tries to add dimensions, which is that the dimensions are always rotational. With billiards, it is a case of curving the trajectories so as to make them pass through all the possible paths they would otherwise ignore. It is as though we needed to twist space in different ways, and indeed, such torsion can

easily be formalised by a vector that wraps itself around a point or a line. So now we will simplify it all by pretending that there is just one, rolled-up dimension.

9. What happens when we switch from one destiny to another?

Right, now we can get down to things that are closer to us and to our own lives: we are going to add a fifth dimension to the cylindrical space-time I showed you just now, a rolled-up and above all macroscopic dimension, so that we can visualise it more easily. This dimension is going to let space-time change shape. But beware - this change is not because space-time itself is moving, for while this is true, it only moves an infinitely small amount. It is because whatever is inside may change considerably at a macroscopic level, as I explained: something quite negligible can provoke huge effects, bifurcations, new scenarios. Keep this image in mind: a disk or a slice of a cylinder represents two dimensions instead of three. So we can include the whole of the universe inside a sphere, here replaced by a slice of cylinder. Now we can shrink this cylinder into a flexible tube, and we can even represent part of this universe, our own human life, for example, by shrinking it further into a piece of string whose length represents time.



Now let us take this rolled-up dimension and make it work: to do so, we have to twist the piece of string by making it rotate around itself in the present, and look what happens: the end of the string doesn't really change position in the present, but its position in the future changes dramatically. What we have to understand is that when we add in a dimension and then move, even just a tiny distance along this new dimension, the whole of space-time changes all at once. This is why twisting the tube or the piece of string is a good illustration for what happens, because we can see quite clearly that this rotation will alter everything in both space and time.

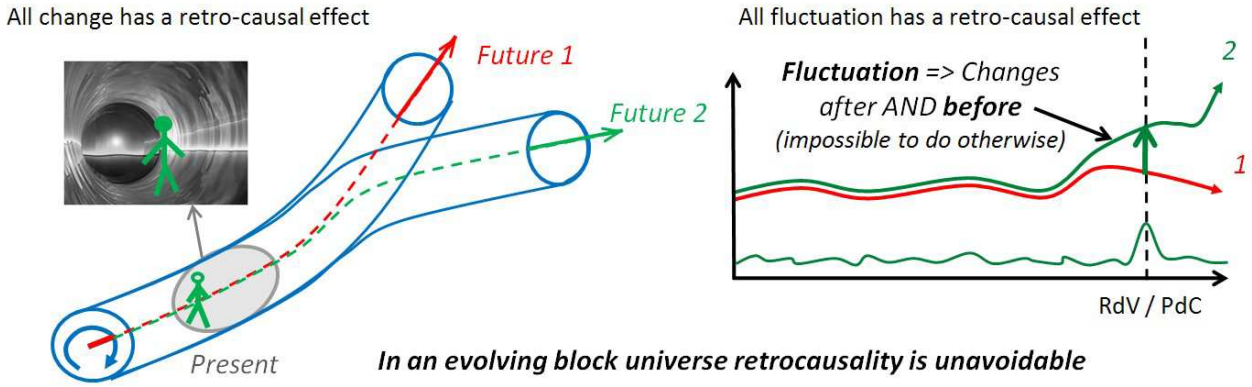
Using this, we can agree with the space-time of loop quantum gravity, which doesn't evolve in the present but simultaneously everywhere in time, due to quantum fluctuations. We can also agree with string theory, because by making the piece of string twist, we end up reconstructing all the possible branches of the multiverse, until the whole thing begins to resemble a tree, what I call the Tree of Life in my book (The Road of Time). The universe has its own tree of life, and each of us has his own, too. The tree is a static representation wherein we can see all possibilities at a glance. Here, I have chosen to show you a tree with cylindrical branches: they are like tubes. This is a vision

painted by Robert Venoza.

Now, let us look carefully at what happens when I twist the tube or piece of string and suddenly change the future, something that can happen at a bifurcation, that is, when the cause is infinitesimally small. For example, if you take a route you don't usually take to go to a regular meeting, you may make the chance encounter of your lifetime, and your life will suddenly change. However, we can't really say exactly when your life changed, because it might have been long before that, if for example one day in the past, one of your friends told you you should shake up your habits a little. This might have suddenly made you become aware of something, so that when you got the chance to act on it, you automatically chose the bifurcation. Meaning that your life didn't change the day you made the encounter, but well before, the day that becoming aware took place. So let us look at what actually happened that day.

10. Retro-causality is inseparable from causality in an evolving block universe

I have illustrated how your life can change in two ways. Top left is change using a tube, and top right is a simple graph with your future on the X axis and a foreign parameter of realisation on the Y axis. The change might not have actually occurred, for example if you were too self-absorbed. In red is where it does occur, and you can see what happens: your future changes, but at that point it becomes impossible that the past immediately preceding the moment of the encounter should not change, even if only a tiny bit, because otherwise it would provoke a breach in the space-time continuum. For we cannot act upon one point in time without simultaneously acting on what comes after AND what comes before. Quite simply in order to respect causality.



Now let us take the model of the tube again, and imagine that it is an invisible tunnel along which each of us travels, automatically guided by illusory free will. The only way to retrieve any authentic free will would be for our thoughts to be able to generate foreign information that would displace our tunnel in the fifth dimension. But also imagine that, as it moves, our tunnel starts to topple over and has to steady itself on something and adjust to the terrain, meaning that inevitably, to maintain causality, a certain retrocausality comes into play to adapt our present to this new future. It is unavoidable, because otherwise a breach opens in the space-time continuum.

Elsewhere, Thibault Damour gives us confirmation that relativity allows for retrocausality and that time is perfectly reversible. The only enemy of retrocausality, in fact, is irreversibility, which spends all its time trying to pry the two twins apart. Irreversibility is in trouble, however, especially if we reason in terms of information, because the information present at the moment of the big bang, especially in a discrete space, obviously has to be infinitely less than the information present today, with all its living systems. And so, since information is the opposite of entropy, this would mean that entropy has decreased, something that goes against the second principle dictated to us by

irreversibility. I believe that this is because the second principle has forgotten the creative effect of foreign information on the future. Foreign information guides the future, that's about the sum of it, and Darwinism needs to be revised. Now, I would like to make it clear that in fact, the question of irreversibility is redundant in indeterminist space-time, or shall we say a space-time determined in multiple ways by foreign variables. This arises from the fact that mechanics does not describe a single future or a single past, but multiple futures and pasts. And the question of irreversibility does not arise in the presence of multiple pasts.

To summarise on the subject of retrocausality, I would like to point out that more and more publications are coming out today on the subject of the influence of the present on the past and especially of the future on the present, including articles in the review *Nature*. I would also like to note that retrocausality in five dimensions has no need for tachyons, or in other words, particles able to travel faster than the speed of light, and lastly I will point out that Bayes' famous equation, emblazoned last month across the cover of *Science et Vie*, which practically presented it like some magic formula, is actually completely trivial in the presence of retrocausality.

Now we will see that retrocausality has the advantage of explaining certain strange phenomena, like coincidences and synchronicities.

11. The mechanics of coincidences and synchronicities

Synchronicity – now here's a phenomenon that might well validate the possibility that our thoughts have some connexion with a fifth dimension, because the foreign information they introduce is the only thing able to explain phenomena that defy causality. We call this Acausality, putting a capital A in front of "causality". This concept was invoked by Jung to explain synchronicity in his correspondence with Nobel Prize-winning physicist Pauli, the father of the concept of Acausality. Synchronicity is coincidence that is loaded with meaning for the person experiencing it. It is this meaning that expresses the fact that our thoughts are part of the phenomenon. Having said that, most of the time we experience mere coincidences, phenomena we often group into different denominations: the "Law of series", "it's a small world", "Murphy's Law", the "Pauli Effect", the "Demo Effect", not forgetting numerical series and above all, CHANCE...

We can understand coincidences using retrocausality, which has a tendency to create synchronous order in the reverse sense of time, because mechanics tends to create disorder in the normal sense. For that to happen, however, the future has to be restructured, meaning that it has to be in the process of changing, which is why coincidences are rare. It is easier, then, to understand the phenomenon by saying that when the future changes, it may be placed in a situation where it has to find new causes, if, for example, the former cause is made more improbable. But we're not really sure how this occurs, which is why synchronicities are the more interesting phenomenon of the two. As far as synchronicities are concerned, we know that they interact with our thoughts and emotions, that they contain a meaning that can make us responsible for changes in the probability of different causes.

Synchronicities can easily be explained if we consider that our intentions can cause effects in the future that become the future causes of an effect in the present. This is an idea also developed by Jacques Vallée, who declared that it will represent a future current in physics, the physics of information, in its conference at TEDx Brussels (2012). In fact, he is the one who made me explore this avenue, more precisely the problematic of Maxwell’s demon, and I have to say that I was surprised to find grounds here to confirm the macroscopic indeterminism which lies at the base of my theory of double causality. Quite simply, this means that we could be living in a world of information that is only partially configured. And it is precisely this that allows us to open the field of possibilities, and that I myself voluntarily tested in order to verify my theory. I explain it in my

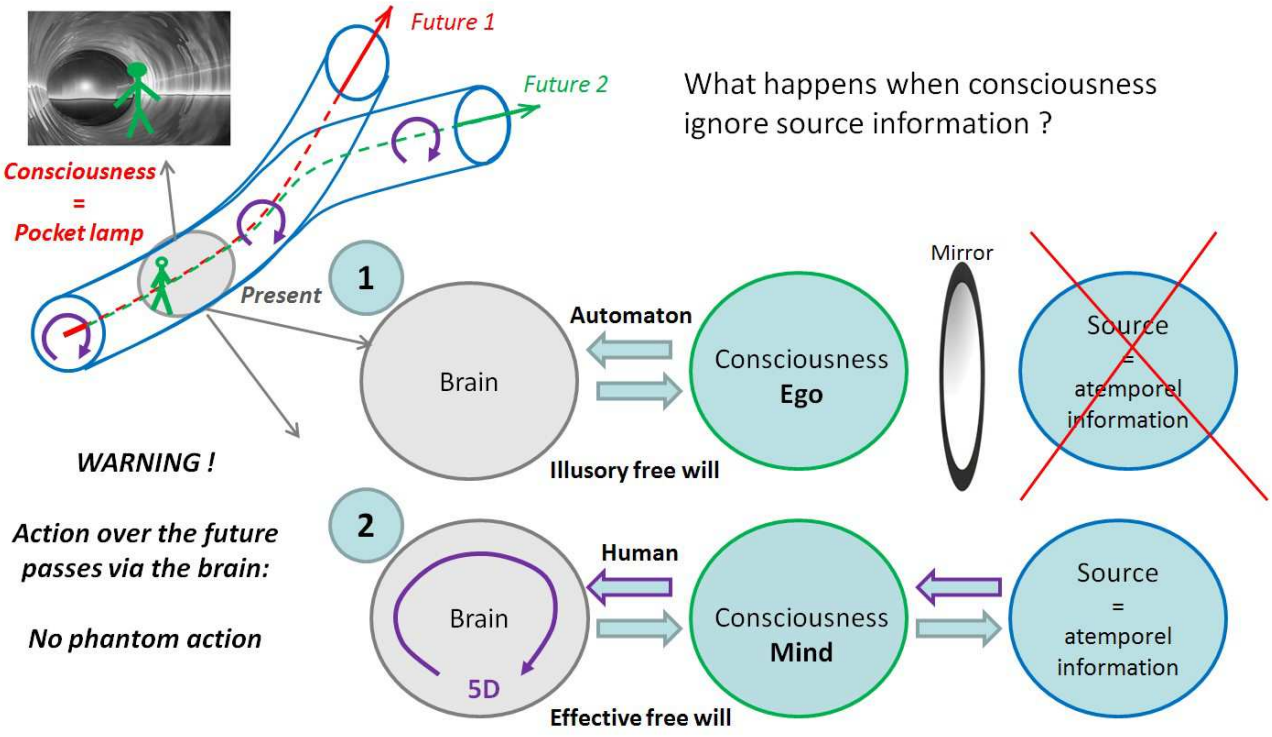
book "The Road of Time". I won't go into it any further now, because it would take too long. All I will say is that provoking synchronicities requires an alertness of the mind, a letting-go, a genuine freedom from conditioning and an openness to changes in one's life. All of this can be summed up in one very simple phrase: everything that isn't determined by the past is determined by the future. Remember my quote from Nietzsche.

I would also like to draw attention to the synchronicity theory of François Martin, a quantum physics theoretician at CNRS. His theory on the quantum psyche brings into play a quantum intrication between two events that may be separated not only in space but also in time, and I think that this atemporal intrication is certainly a key to gaining a better understanding of what I call foreign information. Whatever the case, we will see that intrication or extra dimensions are, in the end, two ways of introducing the same thing, in this case atemporal information.

12. The flexible cylinder: a model for consciousness?

Now I am coming to the main purpose of this lecture, which is to find out what consciousness function could be, and whether we can approach it using a model. I think that when we possess a simple geometric shape that allows us to illustrate something as enigmatic and complex as space, time and extra dimensions, then we should keep it and use it properly.

So I will represent our brain by means of the grey circle inside the tunnel we are each travelling through, unaware that we are being guided, and I will represent our consciousness by means of a pocket lamp that lights our path. I make a distinction between consciousness and brain, because on the one hand, as the conceiver of artificial visual brains, I have absolutely no faith in consciousness magically emerging from complexity, and on the other hand, we have dire need of a serious interface to reduce superposed quantum states, whether they are in the brain or elsewhere in our environment. Our universe of information needs to be observed in order to acquire new material information from all the possibilities available, and it seems to me to be right, as Roger Penrose suggests in his model Orch'OR, that consciousness should play this role.



However, to my mind, what we are talking about here is a passive role that might well be determinist, if in fact consciousness can forget that it is an interface between the brain and a source of foreign information. The ego, of course, is what would tend to make it forget that, something I have illustrated using a mirror for where consciousness is passive. I have also given an illustration below of a model of active consciousness, this time with a source of foreign information, able to act in the fifth dimension by being connected to the brain via consciousness. As you will have realised, I identify this source of information with what we call the Mind. When this source is used, that is to say when there is no ego in the middle acting as a mirror, then information can be transferred from the mind to the brain by consciousness, leading to a change in the brain, characterised by a sense of awareness that instantly alters the future. There is no phantom action, therefore, and everything does indeed transit via the brain. What I am putting forward here, then, is nothing other than a rather materialistic model of consciousness and of the mind, which respects the laws of mechanics and even restores a certain amount of determinism.

To sum up, then, I can identify two functions of consciousness. The first is a passive function. Because it is related to observation in the present and because the universe needs to be observed in order to acquire information, I propose that the first function of consciousness be one of recording the universe.

The second function of consciousness is an active function for configuring the future. It consists of preparing it, informing it via the brain with the help of information from the mind, as long, of course, as this information can reach it. The future is always partially configured, and it is only as it gets closer to the present that the configuration is gradually finalised until it reaches maximum density closest to the present. Thus passive consciousness eventually realises the possibility that has become the most dense, that is to say the most probable, by recording it. In my opinion, therefore, there is no foreign information coming out of nowhere and entering the present, because the immediate future is already prepared. The non local hidden variables are quite simply contained in that immediate future. The action of mind configures reality in a more distant future. However, I think I am only setting out a vague sketch here. This sketch leads me to suggest a link between consciousness and gravity, because all in all, information from a fifth dimension plays the same role as quantum gravity by moving space, but we have to be careful about this. Whatever the case, you will have noticed that this rough model is at once very materialistic, while at the same time being compatible with a certain kind of spirituality.

13. Schrödinger's cat

Now we are better equipped to try to interpret what is happening inside that famous box holding a cat in danger of dying if the apparatus shut inside the box with it suddenly releases a deadly poison. Within the time allotted to the experiment, this apparatus has a one-in-two chance of being activated by a radioactive particle. The problem is that this emission is subject to the laws of quantum mechanics and as a result, the moment it occurs is determinist. But that's not all. Most importantly, there is a possible superposition of states between the alternative where this emission takes place and the alternative that it doesn't, or in other words, the cat is dead and alive at the same time!

Recording and Configuration

Recording

Neither one nor the other

Physicists have argued long and hard over this problem, because a process called decoherence prevents such a superposition of states from existing at a macroscopic level. However, this is not entirely true, because first of all we have already observed superposition phenomena at a quasi-macroscopic level, such as in interference experiments for example, using giant fullerenes, or even superconductors or within the process of photosynthesis. Next, decoherence theory does not properly explain the final phenomenon of state reduction where we cannot in the end manage without an observer. It would seem that this reduction happens naturally, in the absence of any observer, but that it is a question of time, that is to say, there is a very brief lapse of time during which the superposed state exists. So the cat is certainly already either dead or alive when we open the box, but the thought experiment remains valid in theory, because we are allowed to consider that it is indeed dead and alive at the same time, for a certain amount of time.

Now let us suppose that the superposed state actually exists. The real question is whether there is any difference if the cat is conscious or not, or rather, whether it is a real cat or a robot cat. If it's a robot cat, then it is an authentic dead-AND-alive Schrödinger's cat, but if it's a real cat, then it is in some way designed by the universe to provide it with information via its consciousness, in which case it is either dead OR alive. This is where the subtlety lies. And if it's a highly talented human being, capable of provoking its own chance, then we could even imagine that it might be able to stay alive, although we're moving rather into fantasy here, obviously. Whatever the truth, it raises the problem of what happens when the cat is asleep, and that's a question I'm not even going to attempt to find an answer for...

14. Conclusions

To conclude, I think that consciousness has a dual function that can reconcile both the materialistic and spiritualist approach. The materialist approach consists of recording the present and does not reject the neurophysiological determinism affecting the conscience, while the spiritualist approach is concerned with the future and consists of saying that via the mind, consciousness can have an impact on the future. This way, we can reconcile Bergson, Einstein and Nietzsche. Double determinism does indeed exist, but time remains a vehicle for creation and choice nevertheless, via the mind.

Lastly, what I call the theory of double causality, which is quite simply the name I give this model of consciousness, allows us to explain coincidences, synchronicities and even the differences between them. Now, there may be other strange phenomena that could be explained by this theory, but I have preferred to concentrate here on synchronicity. If I could sum up this theory, it would be to recall that it is founded on the macroscopic indeterminism that allows for a possible evolution of the universe outside of time, and that this evolution also appears necessary when we try to reconcile

the theories of grand unification.

15. Perspectives

As I draw to a close, here is something I haven't mentioned in my lecture because it hasn't yet been published or confirmed, but I hope, and I have good reason to believe, that the theory of double causality could offer an explanation for dark matter on several levels: the fact that it predicts how the radiation of a star or other matter could suddenly disappear, something that has already been observed; the fact that the matter whose radiation has disappeared should occur all the more frequently the further away it is; and finally that this self-same radiation might reappear at any moment. All this could be a direct consequence of the fact that the universe's past might evolve, obviously infinitely less rapidly than the future, because of the enormous quantity of traces the past leaves in the present, but even so, it could evolve. The consequence of this would be that former pasts could temporarily block the light... but I won't go any further, because we find it very hard to grasp the concept of these stories about evolving pasts.

Finally, I believe that none of this is very significant compared to what, for me, is the most important perspective opened up by this model. These are things I have experimented with personally, things I have spent a long time thinking about, until I can go so far as to say that I have become deeply convinced of them. I have come to understand that moral and spiritual values such as detachment, giving, authenticity, confidence, faith and intuition are values that are a natural result of the most appropriate behaviour pattern, once we come to understand the nature of time and the information this theory suggests.

Thank you for listening.