Determinism and Free Will
Are they incompatible?

Paulo Gali Macedo *

Resumo

Este trabalho apresenta algumas conjecturas, ainda que sem provas científicas, no sentido de elucidar o problema da existência ou não de uma real incompatibilidade na Natureza entre determinismo e livre-arbítrio. À luz dessas conjecturas, emergentes no contexto da cosmologia, sugere-se que a Natureza é, simultaneamente, determinística e indeterminada, dependendo da perspectiva que cada um possa tomar.

Introduction

The problem of Nature being deterministic or indeterminist has been a long standing Philosophical one. In the Large Scale, the Physical phenomena occurring in nature seem to obey deterministic laws and however, we (human beings) all have the intuitive feeling of being (at least to some extent) free. This dilemma has puzzled human kind since the beginning of our history and went on until the development of Quantum Physics in the middle of last century. Quantum Physics has shown that Nature has some degree of discreetness in particular, that the quantum states allowed to physical systems, as well as its energy levels, are discreet. The quantum description of Nature is a probabilistic one based on the Wave Function which is a probability function. However, the real foundations of Quantum Physics are not yet fully understood and there are some interpretations of it (like the Many Worlds interpretation) which try to make

* Departamento de Matemática Aplicada, Faculdade de Ciências da Universidade do Porto; Email: pgmacedo@fc.up.pt

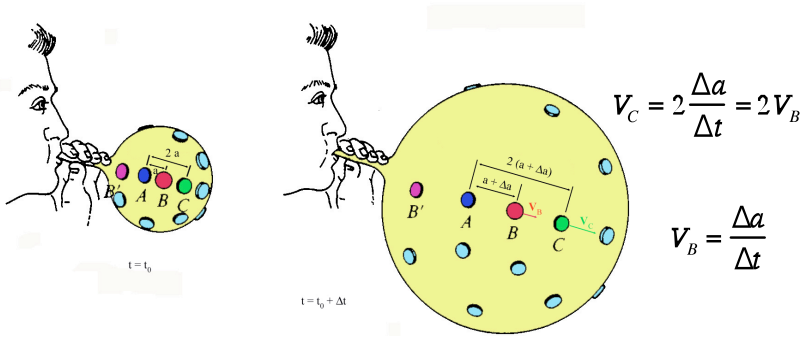
some sense out of it. The proposal made in this paper goes in that direction and tries to reinforce such an interpretation from a Modern Cosmological point of view and show that Nature can be seen as both deterministic and indeterminist depending on the point of view one takes.

The Cosmological Background

The effect of Galaxy Recession was first observed by Edwin Hubble on the decade of 1920. On observing a sample of aproximately 40 nearby galaxies, he noticed a correlation between their distance and the redshift of their spectra (as shown is the figure).

Taking into account the Doppler effect involved, this ment that the velocity at which they are receding from us was proportional to their distance from us. This can be interpreted as a clear indication that Our Universe is presently Expanding.

One can understand this effect using the 2-dimensional analogy of a balloon being inflated with several dots painted on its surface. Different pairs of dots will recede from each other with a velocity which is proporcional to the distance between them.



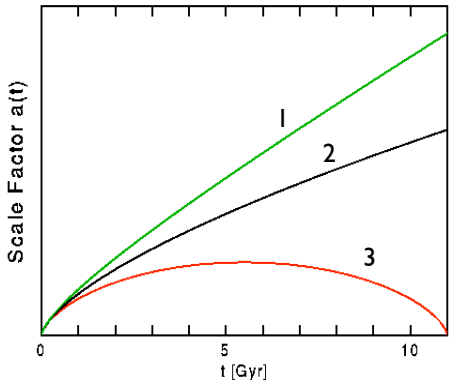
If we think of ourselves as bidimensional creatures living in the surface of the balloon, an observer in A sees the dots B and C receding from him with velocities V_B e V_C which are proporcional to the distance separating them from A. This is due to the fact that in the same time interval □t C is 2□a further apart from A, where B is only □a further apart from A.

Depending on the value of its mean density ρ_U, relative to the critical density ρ_c , the Universe has 3 possible configurations:

1) Open (If $\rho_U < \rho_c$)
   This type of Universe will expand forever.

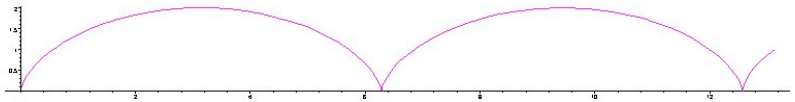
2) Flat (If $\rho_U = \rho_c$)
   This type of Universe will expand forever with an assimptotic limit to its scale factor.

3) Closed (If $\rho_U > \rho_c$)
   This type of Universe has a cyclic behaviour. A Big Bang is followed by an expanding phase, followed by a contracting phase which ends up with a Big Crunch which can give rise to a new Big Bang. This cycle can repeat itself indefinitely.

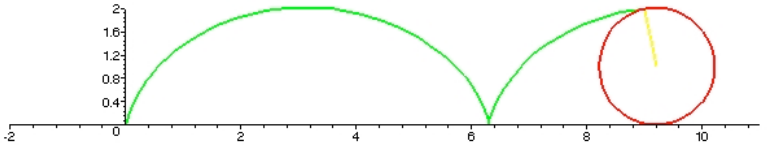


We shall from now on and for the sake of the argument make the assumption that our Universe is a Closed one.

This plot shows the Time Evolution of the Scale factor with cosmic time in a Closed Universe.



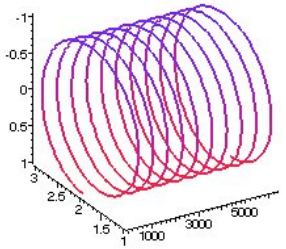
The Cycloid curve in the plot, can be generated by the edge of a circular weel as it rols without slipping on top of straight line:



The point where the radius meets the circumference in this plot gives us a pictorial Bidimensional representation of the State of the Universe (characterized only by the scale factor) along the cosmic time.

However, if one assumes that the inicial conditions in each of the successive Big-Bangs is different, one shall have to use a third axis to characterise the evolution of the boundary conditions in each cycle. We shall have a better visualisation, if we use a Three-dimensional representation, where on the 3rd axis we can represent, some parameter which measures this evolution, like the scale factor of the Momentum Space of the System.

Such a Three-dimensional Representation can be achieved by using the displacement with time of a point along an Helix, as represented in this figure.

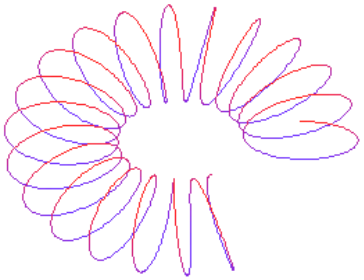


In this representation, the time variation of the Scale Factor is the same as the one in the previous bidimensional animation. However, this one allows the visualization of the evolution, from one cycle to the next along the 3rd axis.

It seems reasonable to assume that the initial conditions in the successive Big-Bangs can vary from one cycle to the next.

Furthermore, it seems to us reasonable to assume that the Universe configurations in successive Big Bangs are closer to each other than in the corresponding moments of Maximum Expansion in the corresponding Cycles.

This is achieved by squeezing the original Helix only in one side and it makes a better pictorial representation of the point we want to make. This corresponds to a different type of curve, which we shall call a Toroidal Helix. This curve can be obtained by rolling an helix around a revolution torus (hence the above mentioned name). The curve obtained in this way is an helix whose axis, is not a straight line but is instead a circumference.

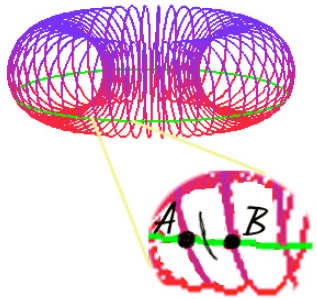


Depending on the ratio of the internal and external radii of the torus, being a rational or irrational number, this curve may do three different things, namely:

Cover densely a Torus.

I.e. the rolling over the torus an infinite number of times, may be such that it leaves no point in the torus which does not belong to a loop.

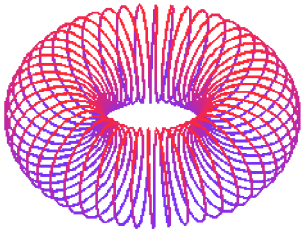
I.e: assuming that for today's cosmic time and in this expansion cycle the configuration of the Universe corrresponds to the point labeled by A and in the next cycle to point B, no matter how near A is from B, out of the infinite number of cycles undergone by the Universe there wil be one in which, for today's cosmic time, the configuration of the Universe corresponds to a point C which lies between A and B. as shown in the figure.



Or, it may also:

Cover discretely the Torus.

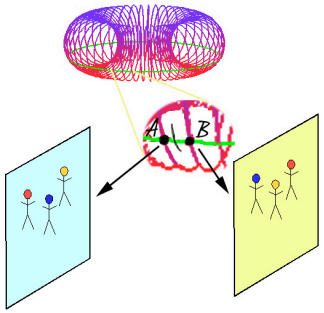
I.e. leaving no areas in the Torus which are densely covered by the curve. I.e. after a finite number of cycles, the curve returns to the same points. This means that there are points in the torus which have no curve passing through them, like the figure next shows. This in turn means that there are configurations of the Universe which are never acessible to it and therefore the possible states of the Universe in different cycles of its existence are discreet.



Parallel Universes

One can think of two different cycles as two Parallel Universes. This means, for example, that if at a given cosmic time (which is measured by the time elapsed from the Big-Bang in the corresponding cycle) we have three characters participating, in one of the Universes, they will be distributed in the blue way whereas in the other parallel Universe they are distributed in the yellow way. In this representation, different Universes at the same

Cosmic Time lie in points which are the intersection of the toroidal helix with a plane orthogonal to the dougnut axis.



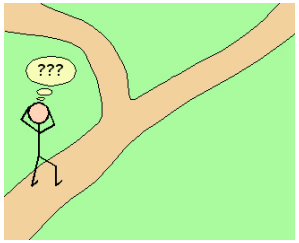
Where is Determinism and Indeterminism?

One can think of the Physical Process which generates the Helix as being completely Deterministic. This means that the unfolding of the Helix can be thought of as causal and deterministic. However, "Corresponding" events occuring in 2 different cycles are different. If the 2 cycles lie nearby in the torus, the events will differ only a little, whereas, if the 2 lie far apart in the torus, they will differ a lot.

However, Quantum Physics seems to show that Nature is indeterministic.

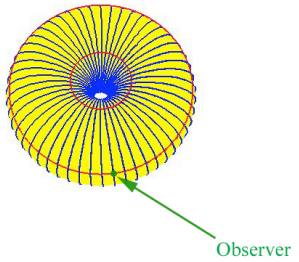
And besides, all of us also have a feeling of having free will. This feeling may be ilusory, however, as a feeling it is very real.

These two views seem totally incompatible, … However we can ask… are they realy that incompatible?



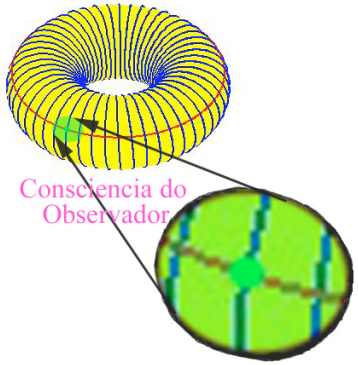
The Identification Process

Now, imagine that there is Only One Conscience which individualizes itself in many separate consciences. The dougnut being its own Creation and playground. However, imagine that its individuations shall only focus on the vicinity of points in the torus loosing, in doing so, rememberence of the Hole. We shall call this focusing process, the Identification Process and we shall call its result an individual Observer or simply Observer.



One can imagine that (at a given Cosmic Time T) the Observer can lie in the vicinity of a point in the Torus corresponding to a given Cosmic Time T in the Helix.

If we now ask – "At a given Cosmic Time and in a given Point (i.e. at a given Space-Time event) where is the Observer's Consciousness?", the answer, based in the Usual Paradigm, would be that it is at a given specific point in the above mentioned toroidal helix corresponding to a specific Cycle which is the one corresponding to the Universe we live in.



However, in this paper we present an Alternative Proposal which is the following:

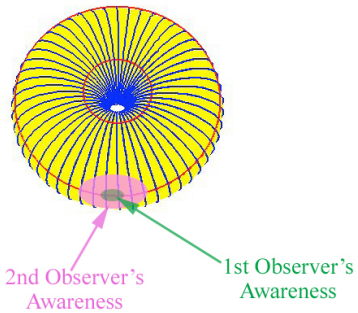
One can imagine that the Conscience of the Observer can lie, at will, in any point in a small neigbourhood of a point in the Torus corresponding to Cosmic Time T in the Helix.

The radius of this neigbourhood may vary both with time for the same observer, as well as from one individual observer to another.

However, when the Observer "Observes", i.e. acts and becomes conscious of its environing "Reality", this neighbourhood collapses to a point in the Helix and this is what quantum physics calls the collapse of the wave function.

What is a so called "Miracle"?

One can imagine that The One Conscience, being its Creator, can focus itself in the hole doughnut at Will. However, its individuations, having, by purpose, lost rememberance of their True Nature, can only focus on a given vicinity of points in the torus. The radius of that vicinity variing from one individuation to another. As this individuation evolves, the process of remembering starts to bring it to the awareness of its True Nature and gradualy the above mentioned neighbourhood starts to enlarge.



In this context, a so called "Miracle" would therefore be, no more than an enlarging of the Observer's awareness (I.e. of the radius of that vicinity) relative to the usual awareness of neighbouring Observers.

Conclusion

So, to the initial question; if Reality is deterministic or not, based on the above proposal, we can answer that it can be both, depending on the point of view:

If we assume Reality to be the Helix, then it is deterministic. If however we assume Reality to be the Conscience which Created the Doughnut, and its Individuations (which in doing so do not in any way become separate from it in their True Nature), and its cognitive process, then it is Free.