Note On The Origin Of Time Asymmetry

A.Faïq*
(Dated: July 2025)

This short paper presents a radical view about time asymmetry.

It will be argued that if one reduces the notion of time to nothing but the order of events, then quantum mechanics, via non-commutativity, gives a plausible explanation as to why physical processes unfold in one direction and not the other.

I. INTRODUCTION

The debate between Newton and Leibniz about the nature of space and time has been crucial in shaping our perception of the world. On the concept of time, Newton argued that it is a real entity which existence is independent of anything else and Leibniz maintained that time is nothing more than the ordering of events.

It has been argued elsewhere that while relativity theory altered our conceptions of space and time, it has been neutral in the debate since it only shifted all talks about space and time to talks about space-time [1]. Therefore the question pertaining to the nature of space and time (or space-time for that matter) is still open. And since modern physics has been essentially Newtonian in the sense that most quantities evolve over a parameter, time, we will explore the alternative viewpoint by entertaining the idea that Leibniz might have been closer to the truth than Newton. In this view, time is nor real nor fundamental. Rather, it is nothing over and above the order of events.

Embracing this position, could one explain why does time have a direction? In other words, could one explain why do events unfold in one order and not the other?

II. ASYMMETRY OF TIME OR ASYMMETRY IN TIME?

First of all, one should have a precise idea of what time means in order to examine its asymmetry.

This paper adopts a well defined notion of time, that is the order of events. Is it then the asymmetry of physical processes in time or the asymmetry of time itself we want to explain?

The answer should be unambiguous. It is the latter, since the asymmetry of time itself would mean the asymmetry in the ordering of events. Thus the question "What is the origin of time asymmetry?" translates without lost of meaning to "why do events happen in one order and not the other?".

III. NON-COMMUTATIVITY

Exactly a century ago, Heisenberg created matrix mechanics and Schrödinger created wave mechanics. The latter is symbolized by the Schrödinger equation:

$$i\hbar\frac{\partial\Psi}{\partial t} = \hat{H}\Psi \tag{1}$$

where Ψ is the wavefunction and $\hat{H}$ the Hamiltonian.

The former is symbolized by the quantum condition:

$$XP - PX = i\hbar \tag{2}$$

where X and P are matrices.

It is a well known fact that this quantum condition led Heisenberg to the uncertainty principle and to the idea that the result of the measurement of X and P depends on the order in which the measurements are carried.

It is my personal belief, and herein lie the radical departure from the orthodox view, that non-commutativity goes beyond measurements and says something deeper about the world we live in.

Suppose I open the fridge and pick up the mayonnaise jar. The act of opening the fridge and picking up the jar are two operations that are non-commutative due to the impossibility of doing the second operation before the first one, and if we label the opening of the fridge as operation A and picking up the jar as operation B then A followed by B i.e. AB is different from B followed by A i.e. BA:

$$AB \neq BA \tag{3}$$

My conjecture is that quantum operations are naturally ordered via non-commutativity and this is precisely what

*abdessamadfaiq@gmail.com

defines an arrow of time. If time is indeed nothing but the order of events then this order has an intrinsic asymmetry that is dictated by non-commutativity. A particle does operation X then operation P in this order but not P then X because of the simple fact that X and P don't commute. Rather we have:

$$XP = PX + i\hbar \tag{4}$$

IV. THE PHYSICS OF PROCESSES

In what have been presented above, I reasoned in terms of operations. A particle might do operation 1 followed by operation 2 and if 1 and 2 don't commute then this will define a natural order from which an arrow of time emerges.

It has been quite an astonishment for me to discover, quite by surprise, that since the 60's David Bohm had been advocating for a radical departure from traditional notions of space and time. He believed space and time not to be fundamental and suggested they be abstracted from an underlying reality which consists of flux, activity and movement. Indeed for Bohm, the concept of process underlies all physical phenomena [2][3].

This is good for one could identify our operations with Bohm's processes. In the scheme I propose, it is not any type of movement that is the basic structure of the world but an ordered type of movement, and it is not any type of process that underlies reality but an ordered type of process. (In a sense, Heisenberg's matrices capture well this position since a matrix, by definition, is an array of elements and embodies some sort of transition, of process).

V. SOME GENERAL REMARKS

-There is no doubt that Newtonian mechanics is a great theory. However, it was Lagrange and Hamilton that revealed its true beauty by reformulating the theory in a sophisticated way. The Lagrangian and Hamiltonian formalisms were later found to be of formidable importance in developing quantum mechanics and quantum field theory.
Perhaps the issue with time is of the same nature. Thinking of time as a real fundamental entity and reducing everything to its passage served us well up until now, but not until physics is reformulated in terms of processes and relations that we will uncover another side of nature. Only then will we be ready to tackle the next intellectual step.

-It is the ability to overcome a deeply ingrained notion that marks a revolution. Copernicus overcame the illusion that the sun orbits around the earth, Galileo overcame the illusion that heavier objects fall faster than lighter ones, and it may be our turn to overcome the illusion that time is a real fundamental entity that governs the change of all processes.

VI. CONCLUSION

Most discussions of time fall short of defining what exactly one is talking about. In this paper, it has been suggested that if one defines time as the order of events then the origin of its asymmetry is to be found in quantum mechanics. There, non-commutativity generates time the same way that the average motion of particles generates temperature. Therefore, time is not fundamental.

In the light of what have been said, it seems adequate to conclude this note by the words of a truly original thinker, J.A. Wheeler [4]:

> "Heaven did not hand down the word time. Man invented it, perhaps positing hopefully as he did that time is Nature's way to keep everything from happening all at once. If there are problems with the concept of time, they are of our own creation!"

[1] Newton-Smith, W. H. (1986). Space, time and space-time: a philosopher's view. In Raymond Flood & Michael Lockwood, The Nature of time. New York, NY, USA: Blackwell. pp.22–35.

[2] Bohm, David (1986). Time, the implicate order and prespace. In David Ray Griffin, Physics and the Ultimate Significance of Time: Bohm, Prigogine, and Process Philosophy. State University of New York Press. pp. 172–208.

[3] Hiley, B. J. (2008). Quantum reality unveiled through process and the implicate order.

[4] Wheeler, J.A. (1989) Information, Physics, Quantum the Search for Links. The 3rd International Symposium Foundations of Quantum Mechanics, Tokyo, 310-336