**(March 2019) UNBELEVABLE similarities between Chiribella et al. (2008, 2013)’s ideas/framework and my ideas/framework (i.e., the EDWs)**

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**[In this paper, I investigate the UNBELIEVABLE similarities between Chiribella et al.’ ideas and my ideas. My main question is: “How was it possible these authors to elaborate their thought experiments without having an ontological background? The answer would be: there are geniuses, of course…]**

**Giulio Chiribella,∗ Giacomo Mauro D’Ariano,† and Paolo Perinotti‡ QUIT Group, Dipartimento di Fisica “A. Volta” and INFM, via Bassi 6, 27100 Pavia, Italy§ (Dated: October 22, 2018): Transforming quantum operations: quantum supermaps arXiv:0804.0180v2 [quant-ph] (22 Oct 2008)**

Abstract

We introduce the concept of quantum supermap, describing the most general transformation that maps an input quantum operation into an output quantum operation. Since quantum operations include as special cases quantum states, effects, and measurements, quantum supermaps describe all possible transformations between elementary quantum objects (quantum systems as well as quantum devices). After giving the axiomatic definition of supermap, we prove a realization theorem, which shows that any supermap can be physically implemented as a simple quantum circuit. Applications to quantum programming, cloning, discrimination, estimation, information-disturbance trade-off, and tomography of channels are outlined.

Channels, states, effects, and measurements are all special cases of quantum operations. What about then considering maps between quantum operations themselves? They would describe the most general kind of transformations between elementary quantum objects. For example a programmable channel [5] would be a map of this type, with a quantum state at the input and a channel at the output. Or else, a device that optimally clones a set of unknown unitary gates would be a map from channels to channels. We will call such a general class of quantum maps quantum supermaps, as they transform CP maps (sometimes referred to as superoperators) into CP maps. In this paper we develop the basic tools to deal with quantum supermaps. The concept of quantum supermap is first introduced axiomatically, by fixing the minimal requirements that a map between quantum operations must fulfill. We then prove a realization theorem that provides any supermap with a physical implementation in terms of a simple quantum circuit with two open ports in which the input operation E can be plugged. This result allows one to simplify the description of complex quantum circuits and to prove general theorems in quantum information theory. Moreover, the generality of the concept of supermap makes it fit for application in many different contexts, among which quantum programming, calibration, cloning, and estimation of devices. To start with, we define the deterministic supermaps as those sending channels to channels. Conversely, a probabilistic supermap will send channels to arbitrary trace-non-increasing quantum operations. The minimal requirements that a deterministic supermap S˜ must satisfy in order to be physical are the following: it must be i) linear and ii) completely positive. Linearity is required to be consistent with the probabilistic interpretation. (p. 1)

Corollary 1 (Delayed reading principle) Every probabilistic quantum circuit is equivalent to a unitary circuit with a single orthogonal measurement at the output.

Quantum supermaps can be applied to a tensor product of quantum operations, namely to a set of quantum operations that are not causally connected (the output of one map is not used as the input for another map). Assorted input sets of states, channels, and measurements can be considered as well, as long as they are not causally connected. Differently, if one wants to map an input set of two causally connected quantum operations, or possibly a memory channel [8], one needs to move to higher level of supermaps, namely supermaps of supermaps [11]. Since the supermap is CP, one can introduce its Choi operator, and then consider the physically admissible mappings. In this way, one can build up a whole hierarchy of supermaps by considering the completely positive maps acting on the Choi operators of the lower level. An efficient diagrammatic approach to treat this problem is provided in Ref. [9] by introducing the notion of quantum comb. The normalization condition for such higherlevel supermaps has a recursive form, entailing the causal structure of input-output relations. (p. 4)

In conclusion, we have introduced the concept of quantum supermap, as a tool to describe all possible transformations between elementary quantum objects, i.e. states, channels, and measurements, with numerous applications to quantum information processing, cloning, discrimination, estimation, and information-disturbance trade-off for channels, tomography and calibration of devices, and quantum programming. A realization theorem has been presented, which shows that any abstract supermap can be physically implemented as a simple quantum circuit. The generality of the concept of supermap, describing any quantum evolution, allows one to use it as a tool to formulate and prove general theorems in quantum information theory and quantum mechanics, and to efficiently address an large number of novel applications. (p. 6)

[In this article, the main idea is a kind of “application” of EDWs in their “supermaps”. However, the framework is UNBELIEVABLE similar to my EDWs perspective! My question is: “How was it possible the authors to elaborate such “supermaps” without having any “ontological background”? the ontological background of their application is my EDWs!!!!!! Of course, because the authors are really geniuses, they did not need any ontological background to elaborate their “supermaps” (i.e., the EDWs!!!).]

**Giulio Chiribella,1, ∗ Giacomo Mauro D’Ariano,2, † Paolo Perinotti,2, ‡ and Benoit Valiron3, § (2013), Quantum computations without definite causal structure, at** [**https://arxiv.org/abs/0912.0195v4**](https://arxiv.org/abs/0912.0195v4)

In this paper we provide a counterexample, showing

that there exist higher-order computations that are admissible

in principle—i.e. their existence does not lead to

any paradoxical or unphysical effect—and yet cannot be

realized by inserting a single use of the input black box in

a quantum circuit with fixed causal ordering of the gates.

Our counterexample consists in the execution of the program

SWITCH, where a pair of input black boxes A and B are connected in two different orders (BA vs. AB) conditionally

on the value of an input bit. The impossibility

of realizing the switch by simple insertion of the black

boxes A, B in a quantum circuit is based on the fact that

such a realization would be equivalent the realization of a

time-travel machine, and therefore would violate causality.

On the other hand, if we give up the requirement

that the computation be realized by inserting the boxes

A, B in a circuit in a definite order, then there are quite

simple ways to realize the switch in a quantum laboratory,

designing quantum circuits where the geometry of

the connections can be entangled with the state of a control

qubit. A similar kind of macroscopic entanglement

is receiving increasing attention thanks to recent experimental

breakthroughs in optomechanics [14–16] and in

quantum optics [17]. (p. 1)

[Again, we have here a pre-supposition of EDWs as an ontological background. However, I am sure they didn’t read my works, therefore they are geniuses elaborating their “thought experiments” with an empty background!!! Also, regarding the last sentence of the above paragraph, they mention a similar “macroscopic entanglement”! However, if the reader go to my PhD thesis from 2007 (posted on UNSW webpage in 2007- FREE) and my book 2008 (posted FREE in the same year on internet), will find the hyperontological background for the macro-EW, micro\_EW and wave-EW!!! UNBELIVABLE similar framework in this article, even if they do not mention any ontological framework but they are able to construct empty thought experiments! Why nobody published such things before I posted my works (with my EDWs) on Internet????]

The first concrete example of a task that can be accomplished

only in the absence of a pre-defined causal

structure has been the execution of the program SWITCH,

which was introduced in Ref. [19], of which the present

paper is an extended elaboration. It is important to note,

however, that the program SWITCH can be simulated by

using one extra query to the input black boxes (cf. section

V of this paper). This means that quantum circuits

powered by the quantum SWITCH are equivalent to ordinary

quantum circuits in the complexity-theoretic sense.

Nevertheless, having access to the quantum SWITCH of fers advantages in information processing: for example,

Ref. [20] demonstrated such an advantage in a black

box discrimination problem, while Ref. [21] exhibited a

task where the use of the quantum SWITCH provides a

quadratic improvement in the number of queries to the

unknown black boxes. Another concrete advantage coming

from undefined causal structure came shortly after

Ref. [19], when Oreshkov, Costa and Brukner presented

a non-local game where a causally unordered strategy

offers an advantage over causally ordered [22]. The noncausal

strategy is described by a legitimate transformation

of boxes, of the kind analyzed in this paper, but such

strategy does not have a clear operational interpretation

in terms of circuits with quantum control on the connections.

As a consequence, it is currently unclear whether

the higher-order transformation of Ref. [22] can be also

implemented by doubling the number of queries to the

input boxes. More generally, the physical realization of

the higher-order computations described mathematically

in this paper is an important open problem for future

research. Having such a characterization is indeed the

crucial step needed to assess the computational power of

the higher-order model of quantum computation.

The paper is structured as follows: in Section II we

briefly recall the framework of quantum circuits. In

Section III we expose the mathematical framework of

higher-order quantum transformations (a.k.a. supermaps

[10, 12]), introducing the notions of transformations on

no-signalling channels and transformations on product

channels, and providing as an example the SWITCH transformation.

In section IV we show that the SWITCH transformation

cannot be realized by inserting the input channels

in a circuit, showing that such a realization would be

a equivalent to the realization of a time machine. In section

V we discuss four ways around the no-go theorem:

having access to program states for the black boxes, using

extra queries, having access to closed timelike curves, and

considering probabilistic implementations of the transformation

SWITCH. The possibility of re-modelling the resource

of two input black boxes with control on the ordering

is discussed in section VI. Before concluding, in

section VII we define the quantum version of the SWITCH

transformation, where the input channels A and B are

transformed in an output quantum channel implementing

a “quantum superposition of the two circuits” AB and

BA. Finally, we summarize the results of the paper in

section VIII, providing a discussion of their implications

and of their relation with other works in the literature. (pp. 1-2)

[for instance: “transformations on no-signalling channels and transformations on product channels, and providing as an example the SWITCH transformation. Or “quantum superposition of the two circuits” AB and

BA.” What do these expression mean? Nothing more than my EDWs!!! Again, these statements send directly to their missing ontological background, that is the EDWs! (even if they mention that: “It is worth stressing that the quantum circuit is a com-

putational circuit—not a physical one: While in the physical

circuit we can have loops (e.g. when a system passes

twice through the same physical device), in the computational

circuit there are no loops (when we apply twice

a transformation to the same system we just draw two

times the same box).” (p. 2)

Many times in the last 10 years, I have been wondering why so few people quotes my name with my ideas. The answer is: many people (from many countries, from many domains, on many topics!!!!) have been publishing UNBELIVALBE similar ideas to my ideas!!! Then how to quote my name????]

From now on, the expression computational circuit

will be referred to a circuit satisfying this set of rules:

1. quantum systems are represented by wires;

2. a box on a single wire represents a transformation

(quantum channel) on the corresponding system, a

box on multiple wires generally describes an interaction

between the corresponding systems;

3. input/output relations proceed from left to right

and there are no loops in the circuit;

4. each box represents a single use of the corresponding

transformation. (p. 2)

[Obviously, these maps send directly to the EDWs!!!!]

In the rest of the paper we will focus on supermaps that

transform a restricted set of quantum channels, namely

the set of (bipartite) no-signalling channels. (p. 5)

Theorem 3 (No classical switch of boxes) The

function SWITCH defined in Eq. (13) cannot be computed

deterministically by a circuit in which the two unknown

oracles f and g are called a single time in a fixed

causal order. (p. 8)

Remark 1 (Impossible switches and impossible

time-travels). As we saw in proposition 1, a circuit

switching black boxes would enable a deterministic time-

travel, where the state of a qubit on the top is teleported

back into the past. It is worth mentioning that the converse

is also true: having access to an hypothetical time

travel machine sending qubits from the future to the past

would allow one to build a computational circuit for the

program SWITCH. (p. 10)

 Proposition 2 (Closed timelike curves enable a

circuit realization of the SWITCH program) If ac-

cess to a closed timelike curve were available, then the

program SWITCH could be implemented deterministically

by inserting the two black boxes f and g in a circuit. (p. 10)

V. WAYS AROUND THE NO-GO THEOREM

The problem with the realization of the program

SWITCH by insertion in a ordinary circuit is due to four

different facts that are assumed in the hypothesis of the

no-go theorem:

1. the facts that the functions f and g are provided

as black boxes

2. the fact that the black boxes can be called only

once in the run of the circuit

3. the fact that time loops are forbidden

4. the fact that the circuit is required to be determin-

istic.

We will now show that, by relaxing any of these requirements,

one can find a way around the no-go theorem

of the previous section. (p. 11)

Another factor that prevents the implementation of

the program SWITCH as a computational circuit is the

requirement that the program succeeds deterministically. (p. 12)

VII. A NEW RESOURCE: THE QUANTUM

SWITCH OF BOXES

While representing automated classical control of

causal sequences of operations allows one to implement

the program SWITCH within the computational circuit

model, it leaves unanswered the question how quan-

tum control of causal sequences of operations can be described.

We can of course imagine a further generalization

of the oracle, allowing for quantum control, with the

control qubit that preserves coherence and becomes entangled

with the causal ordering of boxes f and g as

follows…. To imagine a way to build the controlled gate Wf,g

from the boxes f and g , we need to go beyond the

usual language of quantum circuits, and to consider also

circuits with movable wires that can be also in quantum

superpositions. For example, we can consider a

thought experiment where the physical circuit with movable

wires depicted in Fig. 2 can be controlled by a

qubit in a way that preserves superpositions, with the

control qubit interacting with switches and controlling

them in a correlated way, as represented in Fig. 3. Like

in the Schr¨odinger cat thought experiment, in this case

we would have a mechanism producing entanglement between

a microscopic system (the control qubit) and a

macroscopic one (the position of the switches). (p. 13)

VIII. CONCLUSIONS

Let us start by summarizing the results presented in

the paper: We first analyzed the transformations of nosignalling

channels that are allowed in quantum mechanics.

The transformations considered here take an input

no-signalling channel and transform it in a new output

channel, respecting convex combinations and positivity

and normalization of probabilities. First, we showed that

transformations of no-signalling channels involving two

parties, A and B, can be equivalently defined as transformations

of product channels A⊗B, where A and B are

local channels on A’s and B’s side, respectively. Then, we

analyzed in detail a particular example of such a transformation:

the SWITCH transformation, where an arbitrary

pair of channels (A, B) is transformed in either AB or in

BA depending on the state of a control bit.

The SWITCH transformation can be considered as the

mathematical description of a quantum computation of

higher-order, where the input of the computation is a

subroutine provided as a black box. Such computations

are the kind of computations that would have be included

in a complete, quantum version of Church’s \_-

calculus (cf. Refs. [27–32] for an overview of the different

extensions of Church’s \_-calculus from the classical

to the quantum case). An important fact of higher-order

computations is that, in general, they cannot be implemented

by inserting the input black boxes inside an ordinary

quantum circuit. We illustrated this fact in the

specific example of the SWITCH transformations, showing

that no quantum circuit containing a single call to the

black boxes A and B can implement the transformation

SWITCH deterministically. The reason of the impossibility

is the fact that the transformation SWITCH is incompatible

with any choice of a causal ordering between the

boxes A and B. In fact, in the paper we showed that realizing

the SWITCH transformation by simple insertion of

the boxes in a given order in a circuit would be equivalent

to realizing a time machine, thus violating causality Subsequently, discussed four ways around the no-go

theorem: 1) allowing access to program states, 2) allowing

two queries to the input black boxes, 3) allowing

access to closed timelike curves, and 4) considering

probabilistic simulations. Moreover, we discussed a minimal

change of the rule for describing the oracle access

to the black boxes A and B, introducing classical control

of causal sequences of operations, in such a way that the

computation of the class of higher-order functions including

the SWITCH can be expressed in circuital terms.

Finally, we considered the quantum version of the

SWITCH transformation, which can be implemented if we

allow for quantum control of causal sequence of operations.

A complete physical theory of higher-order computation

has not been developed yet, we expect it to

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reveal unexplored aspects of quantum theory in a nonfixed

causal framework. The quantum switch of boxes

is a new primitive that enables computations where the

causal structure of the connections can be in a quantum

superposition. A quantum computational model in which

the states of quantum systems can control the structure

of a causal network suggests a fascinating analogy with a

quantum gravity scenario, in which the space-time geometry

can be entangled with the state of physical systems.

We believe that exhaustive analysis of higher-order

transformations in quantum mechanics will provide some

new insight for the formulation of a theory of quantum

gravity, within a framework similar to the causaloid

framework of Ref. [40]. The physical implementation

of higher-order functions discussed here has also an interesting

relation to the paradigm of the universe as a

quantum computer [41]. Indeed, one can wonder what

kind of quantum computer the universe is: It could be

a gigantic quantum circuit where information is encoded

in the state of many qubits and is processed in time from

a spacelike surface to the next, or it could be a quantum

Turing machine, or also be a higher-order computer, that

processes information encoded in transformations (e.g.

in scattering amplitudes) rather than in states. Even if

these three models turn out to be equivalent from an

abstract computational point of view, they would nevertheless

remain very different from the physical one, as

they are based on different physical mechanisms. Moreover,

as we already mentioned, the third model has still

to be completely formulated: What is presently lacking

is a complete physical theory that characterizes all transformations

of boxes that are possible in nature. A piece

of Quantum Theory has yet to be explored. (14-15)

Appendix B: Alternative proof of the impossibility of a circuit realization of the switch supermap (15)

**[Again, in all these paragraphs, we can see the missing ontological (in reality, the hyperontological) background that is the EDWs. For instance, “**the impossibility of a circuit realization of the switch supermap” **mirrors exactly the relationship between my EDWs: correspondence!** **It is about the correspondence between EDWs!!!! No more or less! That is their missing ontological background! However, the geniuses do not need any (hyper)ontological background to elaborate “amazing” thought-experiments, do they?]**