Quest Journals
Journal of Software Engineering and Simulation
Volume 3 ~ Issue 5 (2017) pp: 01-13
ISSN(Online) :2321-3795 ISSN (Print):2321-3809
www.questjournals.org

Research Paper

Quantum Cloning on Macroorganisms Containing Quantum Information

Nikolay Raychev
(Affiliation): Varna University Of Management, Varna, Bulgaria

Received 04 Jan, 2017; **A**ccepted 13 Jan, 2017 © The author 2017. **P**ublished with open access at **www.questjournals.org**

ABSTRACT: *This article indicates that the macroorganisms may be cloned. A model for teleportation of internal quantum state and stationary movement of a macroorganism is proposed. This is an important step towards potential teleportation of an organism in the future. In particular, are derived strict limits without signaling for probabilistic cloning and super-replication, which coincide with the corresponding optimally achievable known accuracies and rates. In the context of quantum metrology, the alignment of the reference frame and the estimation of the state at maximum likelihood, the interactions with the world may reveal the current state of the quantum system. This thesis is built around the hypothetical copying of the macroorganism, although the macroorganism contains quantum information. Additional details are given on the equivalence of the asymptotic phase-covariant cloning and the phase estimation for different indicators of the quality.*
Keywords: *Quantum cloning, teleportation, quantum information*

I. INTRODUCTION

The possibility of an organism to be in a state of superposition reveals the deep consequences of quantum mechanics and attracts wide interest. The physicists have made serious efforts in the course of many decades to investigate macroscopic quantum phenomena. To date, are observed wave disturbances in electrons, atoms, and molecules (such as C60). Recently have been carried out two events - cooling in ground quantum state and superposition of states of mechanical oscillators. For instance, a group in Colorado, USA, has cooled the vibration of an aluminum membrane with diameter 15 micrometers to the quantum state and entangled the movement with microwave photons. However, the quantum superposition of the entire organism has not been realized. At the same time, many discoveries were made in the quantum teleportation from the first experimental realization in 1997 with a single photon. In addition to the photons, the quantum teleportation have been proven also with atoms, ions and superconducting circuits. In 2015, a group from the University of Science and Technology of China demonstrated quantum teleportation of several degrees of freedom of a single photon. Nevertheless, existing experiments are still far from the teleportation of an organism. The fundamental reason because of which we cannot clone an unknown quantum state comes down to the fact that the measurements are wave. The associated state is continuous, but the results of the measurements are quantum and overwrite the measured state. For example, the polarization of a photon can be horizontal or vertical or diagonal or anything in between this. But the polarizer can only indicate whether the polarization is along or against the orientation of the polarizer, and in this way the polarizer will impose the polarization to be along the orientation or against it. After the quantum information simply being unclonable, there is nothing that can be done. In order to have a visible reflection in the world, the information must be combined in the environment.

The qubits must affect the measurement in order to have significance. If an unclonable detail is of utmost importance for your identity, subsequently, you must use it. Otherwise, it would not have any influence on your behavior, never (which is not very identifying). But, when you finally use that detail, you disclose its state and can make it susceptible to copying. So, technically, with the copying of the macroorganism must be waited. In reality the principle for absence of signaling is used for deriving the limits and restrictions of several physical processes and tasks. Among them is the observation that a perfect machine for quantum copying would allow for superluminal communication [1-6], restrictions in respect of the universal quantum 1 -> 2 cloning [7, 8] and 1->M cloning [9], proof of security for the quantum communication [10], optimal discrimination of the state [10] and limits of the likelihood of success of the port-based teleportation [2]. Nevertheless, only the absence of signaling is not sufficiently restrictive as it allows stronger non-local correlations than possible within the quantum mechanics [3], and several attempts have been made to further supplement the principle of absence of signaling in order to obtain quantum mechanical correlations [4-7].

Here are derived restrictions in respect of optimal quantum strategies from fundamental principles. In particular, it is shown:

- Strict limit without signaling on probabilistic phase-covariant quantum cloning.
- Asymptotically strict limit without signaling on an unitary super-replication.
- A deviation of the Heisenberg bound for the metrology from the state without signaling.
- Equivalence between the asymptotic quantum cloning and the phase estimation.
- Quantum protocols which achieve the bounds set in the absence of signaling.

It is assumed that the Hilbert space is built of pure states and it is shown how the principle for absence of signaling leads directly to the strict limits on different fundamental tasks in quantum processing of information and quantum metrology. First is presented how the impossibility for superluminal communication between Alice and Bob can be used to provide upper limits on the ability of Bob to carry out certain tasks, even if Bob has access to supra-quantum resources. The principle for absence of signaling not only gives an opportunity to prove the ultimate limits on these fundamentally important tasks, but also allows the demonstration of the optimality of known protocols and the throwing of light on the recently discovered opportunity for probabilistic super-replication of states [8] and operations [9, 10].

It is derived a limit without signaling on the global accuracy of N->M probabilistic phase-covariant cloning [8]. The derivation is constructive and provides the optimal deterministic quantum protocol that achieves the limit [8]. In a similar way is derived a bound without signaling on the replication of unitary operations [9], which is strict in the large M limit. In addition to this is derived the limit of Heisenberg for the quantum metrology solely from the principle for absence of signaling, in particular for alignment of the phase reference [11]. A strict limit without signaling in respect of the maximum probability and a limit with the proper scaling on the accuracy of alignment of the reference frame for the phase is detected both for the uniform as well as for the non-uniform prior probability distribution. It is indicated that the state without signaling can be used for establishing the limits on carrying out the tasks for quantum information for which no limits are known, or for which the optimization through the brute force of the tasks is difficult. This indicates an alternative approach for establishing the capabilities and limitations of the quantum processing of information, based on fundamental principles rather than real protocols. It is emphasized that this approach is not restricted to the specific tasks discussed herein, but is generally applicable. Also here is discussed the conformity between the asymptotic phase-covariant quantum cloning and the estimation of the state for different indicators of the quality, by solving the open problem of whether the asymptotic cloning, quantified by the global accuracy, is equivalent to the estimation of the state [2]. At last, the approach is supplemented by a common argument, which extends that of [3] and shows that the optimal quantum protocols are at the edge of the absence of signaling

II. PROCESS OF COPYING

Here is a basic strategy that I have in mind for copying the quantum macroorganism:

1. Moving to the computer.

- Scanning the macroorganism and its break down to the necessary classical and quantum information.
- To make sure that the *n* qubits of the identity-defining information are moved in the quantum computer.

2. Tracking of what is known for the state.

- Storage in a 2^n x 2^n matrix of density, initialized to the maximum combined state, on an impenetrable powerful classical computer.
- When applying an operation on the qubits defining the identity, the same operation should be applied to the matrix of density.
- When measuring the identity-defining qubits, the matrix of density must be projected into the result of the measurement.
- The new identity-defining qubits should be arranged as known states (*see next paragraph). They should be tensored onto the matrix of density.

3. Simulation and waiting.

- As the simulated macroorganism interacts with the world and the identity-defining core, the measurements of the identity-defining qubits and post-selections of the tracked matrix of density make both to be merged.
- While the gradual process of copying runs, you can calculate the upper limit on how much the tracked matrix of density can deviate from the state, defining the identity.
- Subsequently, the deviations may be small enough so that we basically know the corresponding quantum state.

4. You start printing copies!

- The tracked matrix of density is your copy of the quantum state, defining the identity.

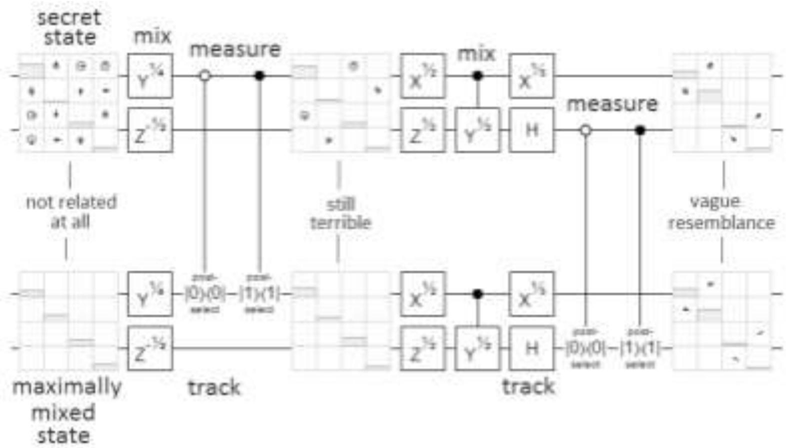


Figure 1An example circuit, demonstrating that even with the intermediate mixed operations, the operations for matching and the post-selection based on the results of the study shifts the tracked state and the secret state closer to one another.

The above diagram is somewhat misleading, because the states it shows are weighted combination of the results of the possible measurement. Also I didn't explain why those controlled post-selections emulate the measurement. And yet I think that this is a good illustration. The individual opportunities look generally the same, only more pure.

Radio countermeasures

There are several ways in which the quantum-computing macroorganisms are resistant to the process of copying outlined above. I will clarify two important ones: large identities and entangled identities. *The large identities* are a problem because the copying, which I defined, uses the classic computer for tracking of what is known about the quantum state. Only with forty qubits of the information, defining the identity, we're talking about yottabytes of storage and performance of the computation (thus the "large" note in the previous paragraph).

It is possible to be found an algorithm, tracking the state (probably a quantum one), which avoids the cost, but the problem for finding a state, which coincides with the given measurements by means of computation, sound to me nearly complete.

The entangled identities cause problems because the external entanglement is impossible to copy without assistance. For example suppose, for the purpose of the task, that the macroorganisms exchange several thousands of electron-paramagnetic resonance (EPR) pairs, when they meet. When meeting again, they demonstrate their identity by answering challenges such as "What will I obtain, if I measure $\mathbf{Q}_{231}$ along **D**?

These confirming the identity EPR pairs:

- can be created by means of an external entity
- are quite prolonged
- are recreated continuously

A constant flow of new unknown states included in the identity will prevent the tracked matrix of density to be converged on purity. The entanglement with an external system (such as another macroorganism) makes the unknownness unavoidable, and will prevent step 3 of the process of copying from stopping. (Only if the other macroorganisms are *also* simulated...)

So that the quantum computing macroorganism may be resistant to copying, but there is more to be added to the history than just the Theorem for no-cloning saying "No!". Even if your identity is created of quantum information, the need to touch that information in order to affect your behavior can allow for subsequent copying. Making the state difficult to copy, while interacting with the outside world via an unreliable quantum computer is an interesting problem of the cryptography.

III. ABSENCE OF SIGNALING

In this section are described the operational conditions behind the three considered tasks (cloning, replication of unitarity, and metrology), as well as the condition for absence of signaling. All three tasks may be described in the following operationally generic setting. A party, Bob, owns an N-qubit state,

$$|\Phi^N\rangle_B = \sum_V a_v |V\rangle_B = \sum_{n=0}^{N} P_n \underbrace{\sum_{|V|=n} \frac{a_v}{p_v} |V\rangle_B}_{|\tilde{n}\rangle_B} \qquad (1)$$

where v passes over all N-bit strings and $|\tilde{n}\rangle_B$ is a superposition of all states with Hamming weight $|V| = n$. Then Bob receives the action of a unitary operator $U_\theta^{\otimes N}$, such that

$$|\Phi_\theta^N\rangle = U_\theta^{\otimes N} |\Phi^N\rangle \qquad (2)$$

where$U_\theta = e^{i\theta H}$ with H a random Hamiltonian action on systems on 2 levels (qubits) with spectral radius $\sigma(H), \theta$, uniformly selected from $0, 2\pi\sigma(H)$

Bob must process $U_\theta^{\otimes N}$ for some task for quantum information in an optimal manner. In particular, it is not necessary the processing of Bob to be described by linear maps, nor it is necessary also the comparison from valid quantum states to probability distributions to be given by the rule of Born. All that is required by the results of the processing of Bob, is they to be valid inputs for someone whose processing power is limited by quantum theory. Such a setting is selected because the objective is rather pragmatic - the upper limits of tasks for quantum information must be derived. Therefore, all the time must be supposed that all static resources of Bob, i.e., pure states of physical systems, pure states ensembles, and probability distributions, are described within the quantum theory, but the dynamic resources of Bob, i.e., processing maps, are not. In fact the imposition of a condition for absence of signaling for quantum static resources is equivalent to the imposition of quantum mechanics (see Section 6), but when a direct optimization on quantum strategies is impossible, the argument for absence of signaling can help for showing that a known strategy is optimal.

IV. HOLDING OF QUBIT

Suppose that Alice possesses certain quantum information, yet she preserves it on the Eve'squantum computer. The storage of information on the computer of Eve is inconvenient. When Alice wants to implement a given operation or to do a measurement of a given qubit, she should ask Eve to perform this for her. Which is annoying. Also, there exists the fact that Eve could spy on the state of Alice.... but Alice realizes that quantumness probably protects it somehow. And Alice does not have her own computer, so it looks like she has no other choice.

Figure 2 Holding of the qubit

Here is a situation diagram:

Eve, in her role of Eve, wants to spy on the information of Alice. More specifically, **she wishes to make a duplicate of the Alice's state,**although she does not know anythingof the initial state and does not dare to implement any operations for which Alice did not asked her. The quantumness sounds difficult, but Eve is inventive. And patient. The theorem for no-cloning guarantees that Eve cannot createan initial state copy $|\psi_0\rangle$. But Eve does not focus on $|\psi_0\rangle$, but wants to copy any $|\psi_t\rangle$. Basically, Alice will explain a process that causes $|\psi_0\rangle \rightarrow |\psi_1\rangle \rightarrow ... \rightarrow |\psi_t\rangle$, but Eve wants to falsify the things in order to happen $|\psi_0\rangle|?\rangle \rightarrow |\psi_1\rangle|?\rangle \rightarrow ... \rightarrow |\psi_t\rangle \otimes |\psi_t\rangle$. To the extent that Alice wants to apply only unitary operations, she avoids the eavesdropping of Eve. The rotation of an unknown quantum state does not disclose anything for that state. But, when Alice requests for measurement, *Eve can see the result.*

Catching a qubit

Suppose that only one qubit is stored from Alice in the computer of Eve. This is a trivial case, as the machine is switched on immediately after the implementation of the first measurement. Each measurement will destroy the state of Alice to either of two options, and the result of the study will reveal to Eve, precisely which option it was.

***(Caution:** The computer of Eve supports only single-qubit studies in the basis of the study, or different-basis measurements, she must cause them with a sequence of operations).*

Let's see an example at which Eve finally receives a copy of the state of Alice:

1. Alice securely loads her state to the computer of Eve.

- The initial state is $|\psi_0\rangle = \frac{1}{\sqrt{2}}|0\rangle - \frac{1}{\sqrt{2}}|1\rangle$.
- Eve does not know $|\psi_0\rangle$, so that she is not able to clone it.

2. Alice requestsfrom Eve to apply the state with a Z portal.

- The state becomes $|\psi_1\rangle = \frac{1}{\sqrt{2}}|0\rangle + \frac{1}{\sqrt{2}}|1\rangle$.
- Eve still does not know anything, so that no cloning can happen.

3. Alice requestsfrom Eve to perform a measurement of the qubit.

- The result of the study is "Off", which Eve reports.
- Eve knows that "Off" conform with the state $|0\rangle$.
- Eve initializes$\boldsymbol{q}_{\mathbf{copy}}$ c $|0\rangle$.

4. Eve wins.

It should be considered that Eve did not performed cloning of the initial state of the qubit of Alice. Eve cloned a state after the measurement, and not the previous unmeasured state. That's why we did not violate the Theorem for no-cloning.

V. ANALYSIS OF A 2-QUBIT SYSTEM

Suppose we observe that one of the qubits has an S_z value of $m_a\hbar$ and the other with $m_b\hbar$ such that $m_a \neq m_b$. The state vector just after this measurement is

$$\left|\Psi\right\rangle = \left|\frac{1}{2}m_a;\frac{1}{2}m_b\right\rangle \text{ or } \left|\frac{1}{2}m_b;\frac{1}{2}m_a\right\rangle \quad ?$$

The two states are physically equivalentfor any complex number α if they are parallel in the Hilbert space

$\left|\psi\right\rangle$ and $\alpha\left|\psi\right\rangle$

but

$$\left|\frac{1}{2}m_a;\frac{1}{2}m_b\right\rangle \neq \alpha\left|\frac{1}{2}m_b;\frac{1}{2}m_a\right\rangle$$

The state vector

$$\left|\Psi\left(m_a;m_b\right)\right\rangle \equiv$$

$$= C\left|\frac{1}{2}m_a;\frac{1}{2}m_b\right\rangle + C'\left|\frac{1}{2}m_b;\frac{1}{2}m_a\right\rangle$$

can be made to satisfy the condition

$$\left|\Psi\left(m_a,m_b\right)\right\rangle = \alpha\left|\Psi\left(m_b,m_a\right)\right\rangle$$

This requires:

$$C\left|\frac{1}{2}m_a;\frac{1}{2}m_b\right\rangle + C'\left|\frac{1}{2}m_b;\frac{1}{2}m_a\right\rangle$$

$$= \alpha\left[C\left|\frac{1}{2}m_b;\frac{1}{2}m_a\right\rangle + C'\left|\frac{1}{2}m_a;\frac{1}{2}m_b\right\rangle\right]$$

$$\Rightarrow C = \alpha C' \qquad C' = \alpha C$$

$$\Rightarrow C' = \alpha^2 C'$$

or $\alpha^2 = 1 \Rightarrow \quad \alpha = \pm 1.$

and $C = \pm C'.$

This gives us two possible physical states:

$$\left|\Psi_S\left(m_a, m_b\right)\right\rangle \propto \left|\frac{1}{2}m_a; \frac{1}{2}m_b\right\rangle + \left|\frac{1}{2}m_b; \frac{1}{2}m_a\right\rangle$$

$$\left|\Psi_A\left(m_a, M_b\right)\right\rangle \propto \left|\frac{1}{2}m_a; \frac{1}{2}m_b\right\rangle - \left|\frac{1}{2}m_b; \frac{1}{2}m_a\right\rangle$$

Suppose, instead, we considered two identical particles moving in one dimension. If one particle was at *x=a* and the other at *x=b*, then there would be two physically equivalent state vectors describing the system just after the measurement, which would be

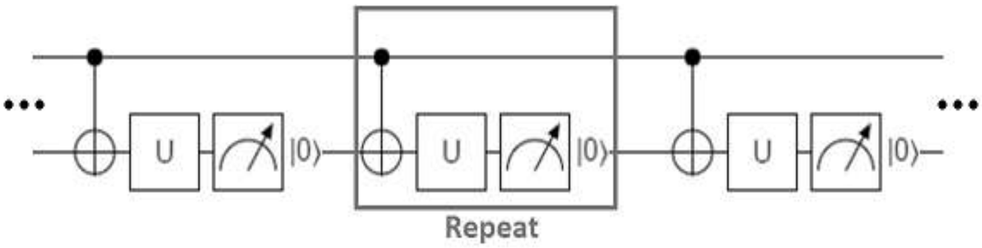
$$\left|\Psi_S(a,b)\right\rangle \propto |a \quad b\rangle + |b \quad a\rangle$$

or

$$\left|\Psi_A(a,b)\right\rangle \propto |a \quad b\rangle - |b \quad a\rangle$$

Alice keeps two qubits in the computer of Eve,namely$\mathbf{q_1}$ and $\mathbf{q_2}$. That is a major step compared to the one qubit, since Alice may combine the things between the measurements. Eve can see a picture of the entire state. A lot can be said for the case with 2 qubits, but let's bring into focus one main thing which Alice can make: obscuration of a value by means of a one-place operation. In particular, Alice will several times ask Eve for CNOT q_1 on q_2, and to do a measurement of pureq_2. But in order to protect the q_1's value, Alice will implement the operation of masking $U = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$to q_2 ,right before the measurement. Here's is the principal scheme indicating the operations that Alice will request Eve to implement again and again.

Figure 3 2-Qubit System



Will Eve be capable of revealing the q_1's value by means of saving the q_2's measurements? In order to reply to that question, we must comprehend how the circuit affects q_1. (Yes, it is affected, although it is used as a control).

Let's assume that q_1 begins in the clear state $x|0\rangle+y|1\rangle$, so the system in general is in that state:

$$|\psi_t\rangle = x|00\rangle - y|10\rangle$$

Perform the application of the CNOT. The result for the new state will be:

$$|\psi_{t+1}\rangle = x\,|00\rangle - y|11\rangle$$

Now perform the application of *U*, continuing the stateto:

$$|\psi_{t+2}\rangle = xa\,|00\rangle + xb\,|01\rangle + yc|10\rangle + yd|11\rangle$$

And finally, we measure q_2 and remove it. As a result there are two possible states, one for the outcome of the "Off" measurement and one for the "On" state:

$$|\psi_{t+3}, OFF\rangle = \frac{xa\,|00\rangle + yc|10\rangle}{\sqrt{|ax|^2 + |yd|^2}}$$

$$|\psi_{t+3}, ON\rangle = \frac{xb\,|00\rangle + yc|10\rangle}{\sqrt{|xb|^2 + |yd|^2}}$$

These factors of normalization are quite approximate. Let's neglect them by bringing into focus the *proportions*in place ofthe precise amplitudes. The proportional values on square $\boldsymbol{Q}$ for q_1, being Off for q_1, being On are:

$$Q_t = |x|^2 : |y|^2$$

$$Q_{t+3,OFF} = |xa|^2 : |yc|^2$$
$$Q_{t+3,ON} = |xb|^2 : |yd|^2$$

On the basis of $U = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, we are aware that $|a|^2=|d|^2$, and $|b|^2=|c|^2=1-|a|^2$. Likewise, we are aware that $|x|^2=1-|y|^2$. This allows us to reduce the number of the variables required for describing the proportions:

$$Q_t = 1 - |y|^2 : |y|^2$$
$$Q_{t+3,OFF} = (1 - |y|^2)|a|^2 : |y|(1 - |a|^2)$$
$$Q_{t+3,ON} = (1 - |y|^2)(1 - |a|^2) : |y|^2|a|^2$$

We define $r_u = \frac{|a|^2}{1-|a|^2}$, and simplify:

$$Q_t = 1 - |y|^2 : |y|^2$$
$$Q_{t+3,OFF} = (1 - |y|^2)r_u : |y|^2$$
$$Q_{t+3,ON} = (1 - |y|^2) : |y|^2 r_u$$

Our last simplification is to change over from the difference $\boldsymbol{Q}$ to the difference from the register Q. We are taking the logarithm of the two sides of Q and we keep track of the odds (let s_u=lg $r_u$for ease of):

$$\tilde{Q}_t = \mathrm{lg}|y|^2 - lg(1 - |y|^2)$$
$$\tilde{Q}_{t+3,OFF} = \tilde{Q}_t - s_u$$
$$\tilde{Q}_{t+3,ON} = \tilde{Q}_t + s_u$$

So the effect of our circuit on $\boldsymbol{q_1}$ is the magnitude on square of the odds from the register and must either be added or subtracted from the constant... And so we are doing a random walk in the space of the difference from the register, with step with a size of s_u!

The limiting behavior is not immediately known. Usually, the random walk likelihood is p for step forward, and is a constant, and whether the walk deviates or not is only a question of verifying whether p is not 50%. However, in our case, $p$ischangingwhile the walk is moving to the left or to the right, it is dependent upon $|\psi_t\rangle$:

$$p = |xb|^2 + |yd|^2$$
$$= (1 - |y|^2)(1 - |a|^2) + |y|^2|a|^2$$
$$= lerp(|y|^2, 1 - |a|^2, |a|^2)$$

Thus the likelihood of a step forward is a straight-line interpolation from $1-|a|^2$ to $|a|^2$, supervised by $|y|^2$. What's that supposed to mean?

Crudely speaking, $|a|^2$, conforms to the extent to which Uenjoys to switch its input data. While $|a|^2$ is around 0, U is almost diagonal and mainly does not switch the input data. "Off" remains "Off", and "On" remains "On". Round about $|a|^2 = 0.5$ the switching is completely unpredictable. When $|a|^2$ is around 1, U is almost anti-diagonal and always switches the input data. "Off" and "On" are swapped.

Recall that $|y|^2$ is only the possibility $\boldsymbol{q_1}$ to be "On". So while $\boldsymbol{q_1}$ transitions from mainly "On" to mainly "Off", p transitions from the switching of U to supplementing the switching of U. Now we possess sufficient information in order to generalize if the steps of the random walk are loaded positively (towards "On") or negatively (towards "Off") in the various cases. As we take into account the likelihood p to step on s_u, rather than against s_u, and the sign s_u, we might make a diagram for the tendency of the walk in a positive or negative direction in any case:
N/A = not applicable

Note: *The N/As in the corner result fromthe circumstance thatthese cases are impossible. They possess a likelihood of 0. The center N/As result fromthe circumstance that the size of the step degenerates to 0 as U is switched to 50%).*

The important thing that must be noted in the table above is that the tendency is "Off" (negative), while the state is "Off", and "On" (positive), while the state is "On". Put it differently, the tendency is*always far from its origin.* This means that the stochastic walk will deviate from either of the infinities; and will not continue to return to the beginning. So q_1 almost merges with "On" or merges with "Off". Based on our analysis, Eve may be able to make a duplicate of the state of Alice by simply waiting reasonable amount of time for the stochastic walk to get away from its beginning. But let's simulate what is happening.

The Hadamard operator (H) creates from the state |0⟩ a superposition |0⟩ |1⟩, and from the state |1⟩ a superposition |0⟩- |1⟩. The proposed algorithm uses the second and third bit to create a pair, thus the Hadamard operator is applied to the second position. Its value is |0⟩, therefore the resultant superposition is:
|0⟩ |1⟩: → |0⟩ (|0⟩ |1⟩) |0⟩ = |000⟩ |010⟩

It is possible by a supplement the multiplication to be spread vectorally, which is useful for presenting the state in more convenient ways to work. At this stage is applied a CNOT operator, an inversion of the third bit in all parts of the superposition, where the second bit is set: → |000⟩ |011⟩ = |0⟩ (|00⟩ |11⟩) The superposition is allready created. *A and B* have by one paired qubit, then it is proceeded to the stage of encoding.

Encoding
***A* initializes the first bit in superposition: □ | 0⟩ □ | 1⟩. Then the state of the entire system is changed to:**
→ (α|0⟩ β|1⟩) (|00⟩ |11⟩)
= α|000⟩α|011⟩β|100⟩β|111⟩

To encode its qubit, *A* applies a CNOT operator on its half of the pair. Thus the second bit is inverted in the parts of the superposition, where the first bit is already set:
→α|000⟩α|011⟩β|110⟩β|101⟩

After the CNOT operator, A applies on its bit also the Hadamard operator (bit # 1). As a consequence of the rule: 0 ->0 1 and 1 -> 0-1, the operation changes the state:
→ α (| 000⟩ | 100⟩) α (| 011⟩ | 111⟩) β (| 010⟩- | 110⟩) β (| 001⟩-|101⟩)
= α | 000⟩ α | 100⟩ α | 011⟩ α | 111⟩ β | 010⟩-β | 110⟩ β | 001⟩-β | 101⟩
With this the process of encoding ends, and it can be proceeded to decoding.

Decoding
The receiving side *B* decodes the received qubit from the classical bits, which it receives. A CNOT operator is applied on the second bit from its part of the superposition, and conditional Z-rotation is applied on the basis of the first bit. The CNOT operator inverts the third bit of a superposition, when the second bit is set, which leads to a state:
→ α | 000⟩ α | 100⟩ α | 010⟩ α | 110⟩ β | 011⟩-β | 111⟩ β | 001⟩-β | 101⟩

Then the Z operator is applied, conditionally from the first to the third bit. The Z operator makes the phase |1⟩ negative, thus each time when the first and the third bit are set, is multiplied by -1:
→ α | 000⟩ α | 100⟩ α | 010⟩ α | 110⟩ β | 011⟩ β | 111⟩ β | 001⟩ β | 101⟩

Then everything is factored again:
= α | 000⟩ β | 001⟩ α | 100⟩ β | 101⟩ α | 010⟩ β | 011⟩ α | 110⟩ β | 111⟩
=(|00⟩| 10⟩ | 01⟩ | 11⟩) (α | 0⟩ β | 1⟩)
= (| 0⟩ | 1⟩) (| 0⟩ | 1⟩) (α | 0⟩ β | 1⟩)

The expression for the third qubit in fact represents the state, which the side *A* has sent. This qubit is received by the *B* side, using only one classical channel, thanks to the paired in advance qubits. The described algorithm similarly could be used also upon pairing of a large number of qubits. All of these applications are hypothetical. More precisely, they all rely on the possibility for storing the state of the qubits for long periods of time. It is not yet known a hardware solution that can provide this. The algorithm also could be used to be increased the reliability of the quantum channel, as well as to be reduced its latency by just sending a constant flow of paired qubits.

VI. SIMULATING AN INFERENCE OF 2 QUBITS

How can Eve trace automatically the state of the system of Alice, not knowing the precise state? Here is a truly naive idea: to be written a list with all the states that are possible, and to be simulated the application of the required operations for every single one of them. When Alice states that rotates a qubit around the axis X, it is passed through each list entry and that rotation is applied around the X-axis. When Alice states to be measured the qubit, a measurement is made on the true qubit then each list entry is post-selected to coincide with the outcome. If the records in the list are primarily in one place, that is the state of Alice.

Of course we cannot list *all* possible quantum states, since they are countless. But we can fill in the space of the state so densely as we want, in such a way so that the true state is nothing more than$e$ far from either of the list entries. (All this is terrible ineffective, but let's neglect that for the time being). It is right to write hacked code which to generateall possible quantum states and to simulatehow those states are changing,while Eve applies them to trace what is going on to the state of Alice. We even can do a nice presentation of the list with states, by arranging the recordings in the sphere of Bloch (although this state has 2 qubits, one of which is known due to the measurements; the other can be figured out). The states are blinking back and forthas the stochastic walk is happening. Subsequently, the true state is sufficiently far enough from the center so that the probability of outer curve overcoming and equator returning is minimum. The true state is pulled to the pole and, because the true state dictates the results of the study, they control thestochastic walk, and the remaining states gather around it. Possibly 2-qubit cases can be created when the process of inference of Eve will not merge such as that one, but prior tospeak about that, we have to discuss the matrices of density.

Matrices of density and inefficiency

The process of inference by a list of the states that I described above is a simple but terrible inefficient. We list preposterously a lot of states that to receive good coverage in the space of the state. It is evident that there is room for improvement.A far better wayfor tracing what do you know about a given quantum state is to use a matrix of density

$$\rho(\mathbf{r},\mathbf{r}') = M\sum_m \int d\mathbf{x},\cdots d\mathbf{x}_M \psi^*(\mathbf{r},s,2,\ldots,M)\psi(\mathbf{r}',s,2,3,\ldots,M)$$

$$n(\mathbf{r}) = \rho(\mathbf{r},\mathbf{r})$$

$$\rho(\mathbf{r},\mathbf{r}') = \sum_k\sum_m \varphi_k^*(\mathbf{r},m)\varphi_k(\mathbf{r}',m) = \sum_k\sum_{m,m'} \varphi_k^*(\mathbf{r},m)\varphi_k(\mathbf{r}',m')$$

Exchange states:

$$K = -\frac{1}{2}\sum_{k,\ell}\int d\boldsymbol{x}d\boldsymbol{x}'\,\frac{\varphi_k^*(\boldsymbol{x})\varphi_\ell^*(\boldsymbol{x}')\varphi_\ell(\boldsymbol{x})\varphi_k(\boldsymbol{x}')}{|\boldsymbol{r}-\boldsymbol{r}'|}$$

$$= -\frac{1}{2}\sum_{k,\ell}\sum_{m,m'}\int d\boldsymbol{r}d\boldsymbol{r}'\,\frac{\varphi_k^*(\boldsymbol{r},m)\varphi_\ell^*(\boldsymbol{r}',m')\varphi_\ell(\boldsymbol{r},m)\varphi_k(\boldsymbol{r}',m')}{|\boldsymbol{r}-\boldsymbol{r}'|}$$

$$= -\frac{1}{2}\int d\boldsymbol{r}d\boldsymbol{r}'\left(\sum_{k,m}\varphi_k^*(\boldsymbol{r},m)\varphi_k(\boldsymbol{r}',m)\right)\left(\sum_\ell\sum_{m'}\varphi_\ell^*(\boldsymbol{r}',m')\varphi_\ell(\boldsymbol{r},m')\right)$$

$$= -\frac{1}{2}\int d\mathbf{r}d\mathbf{r}'\,\frac{\rho(\mathbf{r},\mathbf{r}')\rho(\mathbf{r}',\mathbf{r})}{|\mathbf{r}-\mathbf{r}'|}$$

$$= -\frac{1}{2}\int d\mathbf{r}d\mathbf{r}'\,\frac{|\rho(\mathbf{r},\mathbf{r}')|^2}{|\mathbf{r}-\mathbf{r}'|}$$

I will not explain how these matrices of density work in this article. It is sufficient to say that, while taking account the probability for distribution of the possible quantum states, you can calculate the appropriate matrix of density. It is easy to be applied operations and measurements and post-selections of the matrices of density. And if two probabilities for distributions of the states are provided with the same matrix of density, then both distributions are impossible to distinguish between. Essentially, rather than tracking who knows how many states, we may apply operations to a unique matrix $2^n\times2^n$. Not only is this more effective, but also enables us to make use of standard methods for calculating how much uncertainty remained in the process of inference (through the entropy of von Neumann) and how to compare the inferred state by means of the true state (through tracing the distance). Of course, the operation on the matrix $2^n\times2^n$ is *a bit expensive.* This updated algorithm of the inference is superior, but not yet sufficiently clear before the qubits number n to become somewhere around 100. The operation of the algorithm is guaranteed for the small cases, but for the large cases it is a simple demonstration that the security against a possible cloning is based upon a calculation of the difficulty of the assumption rather than of unconditional security. We attempted to prove that the difficulty of the assumption that we do is great, but we failed to do it. Making a copy through inference *seems* easy, but each time when I attempt to do a reduction of 3-SAT, or anything I find, I made Alice to come up with the solution, rather than making Eve. (*Note: The task of Eve is trivial, if she possesses a quantum machine for post-selection. But such do not exist in reality).*

VII. SIMULATING MORE QUBITS AS INFERENCE

To show that the solution with a matrix of density may actually operate, I applied it.

The states$\alpha \circ (\delta\alpha^1 \circ \delta\alpha^2)$ may be expanded as

$$(\alpha + d\alpha)^\mu = \phi(\alpha, \delta\alpha) = \phi^\mu(\alpha, 0) + \left.\frac{\partial \phi^\mu(\alpha, \beta)}{\partial \beta^\lambda}\right|_0 \delta\alpha^\lambda + \cdots$$

The Euclidean element $\delta V(\varepsilon)$ expands as it is moved around by the factor

$$\alpha \circ \delta V(\varepsilon) = \delta V_L(\alpha) = d\alpha^1 \wedge d\alpha^2 = (\delta\alpha^1) \wedge \left(e^{\alpha^1}\delta\alpha^2\right)\delta V(\varepsilon).$$

The weigh in the vicinity of α by a factor$e^{-\alpha^1}$:

$$\text{Invariant volume element} = \text{density} \times \text{Euclidean volument elelment.}$$

For the right translation by $\alpha,$ we have,

$$\delta V(\varepsilon) \circ \alpha = \delta V_R(\alpha) = d\alpha^1 \wedge d\alpha^2 = (\delta\alpha^1) \wedge (\alpha^2\delta\alpha^1 + \delta\alpha^2) = \delta\alpha^1 \wedge \delta\alpha^2 = \delta V(\varepsilon).$$

The volume they enclose is give by

$$\delta V(0) = \rho(0)\delta\alpha^1 \wedge \delta\alpha^2 \ldots \delta\alpha^\eta.$$

Move this element to an arbitrary element $dV(0)$ to an arbitrary group α by left translation, and demand of the density function that

$$\rho(0)dV(0) = \rho_L(\alpha)dV_L.$$

Here $dV_L(\alpha)$ is the Euclidean volume element $dV(0)$ after it has been moved from the vicinity of (0) to the vicinity of (α) by left translation with α.It is easy to compute dV_L:

$$dV_L(\alpha) = d\alpha^1 \wedge d\alpha^2 \wedge \ldots \wedge d\alpha^\mu,$$

$$(\alpha + d\alpha)^\mu = \phi^\mu(\alpha,\backslash\delta\alpha) = \phi^\mu(\alpha, 0) + \left.\frac{\partial \phi^\mu(\alpha, \beta)}{\partial \beta^\lambda}\right|_{\beta=0.}$$

Then we have

$$dV_L(\alpha) = \left.\frac{\partial \phi^1(\alpha, \beta)}{\partial \beta^{\lambda^1}}\right|_{\beta=0} \delta\alpha^{\lambda^1} \wedge \left.\frac{\partial \phi^2(\alpha, \beta)}{\partial \beta^{\lambda^2}}\right|_{\beta=0} \delta\alpha^{\lambda^2} \wedge \ldots \wedge = \det \left\|\frac{\partial \phi^\mu(\alpha, \beta)}{\partial \beta^\lambda}\right\|_{\beta=0} dV(0).$$

The density for left translations must thus satisfy $(\rho(0) = 1)$

$$\rho_L(\alpha) = \left\|\frac{\partial \phi^\mu(\alpha, \beta)}{\partial \beta^\lambda}\right\|_{\beta=0}^{-1}.$$

Doing all of the above for the right leads to

$$\rho_R(\alpha) = \left\|\frac{\partial \phi^\mu(\beta, \alpha)}{\partial \beta^\lambda}\right\|_{\beta=0}^{-1}.$$

Eve finally managed to invent a quite good duplicate of the state of Alice, in spite of my efforts to complicate the things.

That which can not be cloned

Up to this moment I think that I conclusively found thatoccasionally Eve may reveal the state of the system of Alice and thus to establish a clone. I mean that, I literally provided a working model. But there may be also situations in which Eve can not reveal the whole state of Alice.

Foremost, there could be statedetails, which do not concern any measurements. Recall how, in the case with two qubits we have analyzed the size of the step of the random walk, and when the switching of U reached 50%it degenerated to 0. The setting of the switch to 50% led to the fact that Eve did understood nothingfor the qubit q_1, as the q_1's state no longer affects any results from the study. If the ultimate goal of Eve is to predict the probabilities of the measurements of Alice, then not revealing details, which do not affect those possibilities is good. But even so, it is quite difficult for Eve to understand whether she has any significant details or not. To determine whether the program of Alice will use ever specific qubits is difficult, and the stopping of the problem is incomputable.

Second, if the quantum computer of Eve is able to perform communication with different quantum computers, Alice may request Eve todo external states entanglement of her state. This presents an issue for Eve because, even though an EPR pair as a unit is possible to be cloned, it is not allowed to clone half of an EPR pair. This literally makes no sense: If you are looking for qubit, which is in agreement with a, and not with b, (or else you would have a GHZ state rather than a clone), although b is in agreement with a. Alice can incorporateexternal entanglement as an original state, but that does not present an issue. The process of inference of Eve copes with this. The problem is that if Alice may add new entanglement: This is the only way in which she may add entropy in the inferred matrix of density of Eve.

Thirdly, there is a pragmatic issue for the size. The algorithm of inference of Eve for n qubits and m operations works as $O(4^n m)$. Thus, a simple way for Alice to beat the naive Eve is simply to connect in the state 100 qubits. On the contrary,practically, Eve would not be naive to such extent. She will seek opportunities by means of which to neglect some of the qubits, or, to perform a measurement of them earlier, or to create the state in independent sub-parts. There are many ways in which Alice could accidentally make the matters quite easy for Eve.

VIII. THE QUANTUM INFORMATION IN THE MACROORGANISMS

What's that supposed to meanon inferring the state of the quantum information in the macroorganism?
This means that it is not possible the quantum architecture of the macroorganisms to be resistant to cloning. The quantumness is necessary for the resistance of cloning, but it is not sufficient. By loading the macroorganism in the quantum computer-clone of Eve and simulating its normal operation, we can understand all hidden details. The process of locking does not work, if the macroorganism continuously updates the external entanglement. And the details which were not used will make it difficult to understand whether we have completed or not. And the long-lasting qubits with exponentially smalleffect on the measurements may add to the process a considerable amount of time. And we will get stuck quite a lot in practice if we cannot recreate the process in 30-qubit subsystems. However. Here the security is conditional.

Notes

- **Can the measurement of the non-changing observables, which has arbitrary unexpected results, degrade the approximate value of Eve?**

(*For example, can setting the qubit to* $|0\rangle+|1\rangle$ *and measuring it, make an information unknown for Eve?)*
No. The entropy is added in the state by the measurement, but it is immediately revealed with the outcome of the study.
The 4-qubit simulation above in fact makes this. It does not hinder the process of inference. Eve may be upset when incredible researches happen, as the inference can give a wrong response, but the entire tendency is to be strengthened.
The only way to be added with certainty an entropy to the inferred matrix of the density of Eve is to introduce external entanglement.

- **And what happens with the ancilla qubits, which are not measured (such as the algorithm of Deutch-Josza)?**

The final values of the ancilla qubits usually do not matter or are implied from the measurements that *are* made. Therefore, after the algorithm is over, they simply will break down (i.e. they are measured, but there is no need to worry to record the result).
You are able to try this casefreely! For example, a typical example circuit of Deutch-Josza has an unnecessary ancilla bit. Does Eve succeed to reveal it as Alice runs the circuit??

- **Doesn't this contravene the Theorem for no-cloning?**

No. We do not clone an unknown state, we produce a known state. It is interesting how we got to know for this state.

- **Practically wouldn't the errors in the measurement and other inherent noise sources be an issue?**

Perhaps. But this may also be a source. For example, all states reachable through a permissible noise may be considered as copies for our objectives.

- **The process of inference is absurdly intractable.**

Yes. However, the existence of calculable process of inference degrades the security from unconditional to difficult for calculation assumption.

IX. DISCUSSION

A. Tightness of bounds

It was already shown that the condition for absence of signaling may set upper limits on several important tasks for quantum information, such asunitary replication, cloning, and metrology. In the case of PCC and unitary replication it was presented that the limit without signaling coincides with the optimal quantum-mechanical strategy, suggesting that the quantum-mechanical strategies for phase-covariant quantum cloning and unitary replication are at the edge of absence of signaling. Nevertheless, for the case of the metrology, and in particular for the mean accuracy of estimation, it is seen that there is a gap between the limit without signaling and the optimal quantum strategy. Could this gap be an indication for the existence of a supra-quantum strategy, compatible with the absence of signaling, that excels the best quantum-mechanical strategy? The answer is no, as will be explained below.

B. Quantum mechanics at the edge of the absence of signaling

The above argument shows that the probability distribution of equation (2) is only valid for one possible scenario without signaling, and that in order to obtain a stricter limit should be consider all possible states, shared between Alice and Bob, and all possible measurements at the side of Alice that direct the partial state of

Bob in different ensembles from pure states corresponding to the same matrix of densities. Would such an optimization remove the gap between the limit without signaling and the optimal quantum strategy?

Following [3], let's now show that such an optimization is not even needed, as only the processing, compatible with absence of signaling is given by the rule of Born

This indicates that each dynamic evolution of the quantum states which takes into account the absence of signaling is necessary described by an entirely positive map [3]. The results of [14] relate to situations where the raw data from the processing of Bob are quantum-mechanical states. In this case [15] suggests that the optimal quantum-mechanical strategies are at the edge of the absence of signaling. But in the same case of quantum metrology the output data are probability distributions. It should be noted that in [16] the validity of the rule of Born is accepted and used to derive the probability for remote preparation of an ensemble state and for obtaining a restriction of the linearity of equation (2) from the indistinguishably of the processed ensembles. In this case supra-quantum metrology is excluded. If no assumptions are made about how the probabilities are set to the measuring results of quantum states, but only take remote preparation of a state as an experimental fact, the restriction for absence of signaling already implies the rule of Born.

For systems with dimension $d > 2$ this can also be considered as a consequence of the theorem of Gleason (it is sufficient to examine all ensembles of pure states, forming an orthonormal basis). Furthermore, a similar result for the equivalence of CP dynamics and the rule of Born applied by linearity are known to withstand in a more general context to probabilistic theories with purification [4]. Briefly, it was shown that also in the case of quantum metrology the optimal quantum-mechanical strategies are at the edge of the absence of signaling.

C. Probabilistic vs deterministic limits

It should be noted that all limits without signaling derived here are dealing with probabilistic strategies. This is the most transparent in the deriving of a limit without signaling for unitary replication. In some cases, the optimal deterministic strategy coincides with the optimal probabilistic, such is the case for the replication of unitaries. In other cases the optimal probabilistic strategy can be made deterministic, if several constraints on the input alphabet are removed, as in the case for cloning of states, when entangled input states are permitted in lieu of separable input states. How does someone decide whether a deterministic limit still withstands when probabilistic tasks are permitted? If this is not the case, could it be achieved a probabilistic implementation deterministically, by allowing more common input states? It is known that, in principle, each probabilistic strategy can be decomposed in a filter, F, acting on the input state and comparing it to an output state in the same Hilbert space, followed by a deterministic transformation [18].

X. CONCLUSION

If you do tell anybodyall the things you make to the secret quantum state of yours, and what results from the study you get, it gradually ceases to be secret. A given quantum computer is aware of everything that you're requestingit to make to the secret quantum state of yours, and what results from the study you will receive. In general, in certain cases, a careful quantum computer may gradually reveal in what state it operates. The quantum information setting in the macroorganism is of necessity, but not sufficient, for unconditional no-cloning security. In this article are derived limits without signaling for different tasks for quantum processing of information. Among them are the phase-covariant cloning of states and unitary operations, as well as quantum metrology. In the latter case it was shown that the validity of the limit of Heisenberg is entirely from the condition for absence of signaling. Following [3], it was shown that the optimal probabilistic quantum-mechanical strategy is at the edge of the absence of signaling also for the case of metrology. Something more, it was found that for certain tasks, such as e.g. PCC of states and unitaries, the optimal probabilistic and deterministic strategies match. These results reveal a connection between the principle for absence of signaling and the finite bounds on the quantum cloning and metrology. This connection provides a new perspective to the physical origin of these bounds, unlike the previously known bounds on the basis of the optimization, by means of semidefinite programs.

On the one hand it is clear that the limit for probabilistic strategies is also a limit for deterministic such. Although, it might be possible to be defined more strict limits without signaling for deterministic strategies. This is an interesting open question how to include the requirement that the protocol to be deterministic in a scenario without signaling. On the other hand, there are several tasks for which is unknown the optimal quantum strategy. In such cases the techniques and methods proposed here may be particularly useful when deriving restrictions on these tasks on the basis of the absence of signaling. We have shown such an example for the Bayesian metrology, but the demonstrated methods are applicable in a wider context. This ensures an alternative approach to study the possibilities and limitations of quantum processing of information.

REFERENCES

[1]. N. Gisin, Helv. Phys. Acta **62**, 363 (1989); Physics Letters A **143**, 1 (1990).
[2]. J. Polchinski, Phys. Rev. Lett. **66**, 397 (1991).
[3]. C. Simon, V. Buˇzek, and N. Gisin, Phys. Rev. Lett. **87**,170405 (2001).
[4]. N. Herbert, Found. Phys. **12**, 1171 (1982).
[5]. G. Ghiradi and T. Weber, Lettere Al Nuovo CimentoSeries 2 **26**, 599 (1979).
[6]. P. Sekatski, M. Skotiniotis, and W. Dür, No-signaling bounds for quantum cloning and metrology, *Phys. Rev. A* 92(sn2), 022355 (2015).
[7]. N. Gisin, Phys. Lett. A **242**, 1 (1998).
[8]. S. Ghosh, G. Kar, and A. Roy, Phys. Lett. A **261**, 17 (1999).
[9]. Nikolay Raychev. Ensuring a spare quantum traffic. International Journal of Scientific and Engineering Research 06/2015; 6(6):1355.1359. DOI:10.14299/ijser.2015.06.002, 2015.
[10]. J. Barrett, L. Hardy, and A. Kent, Phys. Rev. Lett. **95**,010503 (2005).
[11]. J. Bae, W.-Y. Hwang, and Y.-D. Han, Phys. Rev. Lett.**107**, 170403 (2011).
[12]. Nikolay Raychev. Indexed cluster of controlled computational operators. International Journal of Scientific and Engineering Research 09/2015; 6(8):1295, 2015.
[13]. Nikolay Raychev. Quantum multidimensional operators with many controls. International Journal of Scientific and Engineering Research 09/2015; 6(8):1310. DOI: 10.14299/ijser.2015.08.007, 2015.
[14]. G. Brassard, H. Buhrman, N. Linden, A. A. Methot, A. Tapp, and F. Unger, Phys. Rev. Lett. 96, 250401 (2006); N. Linden, S. Popescu, A. J. Short, and A. Winter, Phys. Rev. Lett. 99, 180502 (2007); P. Skrzypczyk, N. Brunner, and S. Popescu, Phys. Rev. Lett. 102, 110402 (2009).
[15]. M. Paw lowski, T. Paterek, D. Kaszlikowski, V. Scarani, A. Winter, and M. Z_ ukowski, Nature 461, 1101 (2009).
[16]. M. Navascues and H. Wunderlich, P. R. Soc. A-Math. Phys. 466, 881 (2010).
[17]. T. Fritz, A. B. Sainz, R. Augusiak, J. B. Brask, R. Chaves, A. Leverrier, and A. Acn, Nat. Commun. 4 (2013).
[18]. G. Chiribella, Y. Yang, and A. C.-C. Yao, Nat. Commun. 4 (2013).