Journal of Infectious Diseases & Research
JIDR, 2(1): 32-38
www.scitcentral.com

Review Article: Open Access

Quantum Resourrection: Quantum Algorithm with Complex Conjugation Reverses Phases of the Wave Function Components

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Received April 07, 2019; Accepted April 14, 2019; Published June 22, 2019

ABSTRACT

Light is a powerful tool to manipulate matter, but existing approaches often necessitate focused, high-intensity light that limits the manipulated object's shape, material and size. The breakthrough development could lead to spacecraft without fuel. What if a spacecraft could travel through our solar system powered and accelerated using only light? That's the goal of new research coming out of Caltech. More federal spending on directed energy weapon research and development has some stakeholders looking for operational systems to deploy in the next two or three years. The weapons which use focused energy in the forms of lasers, microwaves and other methods against targets ranging from drone swarms to ballistic missiles — have long drawn the interest of the Department of Defense and its military services but have previously been relegated largely to the arena of the theoretical. They have artificially created a state that evolves in a direction opposite that of the thermodynamic arrow of time. Scientists have reversed the direction of time with a quantum computer.

Keywords: Quantum resourrection, Quantum algorithm, Complex conjugation, Quantum state, Photonic levitation, Propulsion of nanostructured macroscopic objects, Quantum entanglement entropy, Artificial photosynthesis, Directed energy weapons

SELF-STABILIZING PHOTONIC LEVITATION AND PROPULSION OF NANOSTRUCTURED MACROSCOPIC OBJECTS

Light is a powerful tool to manipulate matter, but existing approaches often necessitate focused, high-intensity light that limits the manipulated object's shape, material and size. Here, we report that self-stabilizing optical manipulation of macroscopic—millimetre-, centimetre- and even metre-scale—objects could be achieved by controlling the anisotropy of light scattering along the object's surface. In a scalable design that features silicon resonators on silica substrate, we identify nanophotonic structures that can self-stabilize when rotated and/or translated relative to the optical axis. Nanoscale control of scattering across a large area creates restoring behaviour by engineering the scattered phase, without needing to focus incident light or excessively constrain the shape, size or material composition of the object. Our findings may lead to platforms for manipulating macroscopic objects, with applications ranging from contactless wafer-scale fabrication and assembly, to trajectory control for ultra-light spacecraft and even laser-propelled light sails for space exploration.

Researchers at Caltech have designed a way to levitate and propel objects using only light, by creating specific nanoscale patterning on the objects' surfaces. Though still theoretical, the work is a step toward developing a spacecraft that could reach the nearest planet outside of our solar system in 20 years, powered and accelerated only by light. A paper describing the research appears online in the March 18 issue of the journal Nature Photonics. The research was done in the laboratory of Harry Atwater, Howard Hughes Professor of Applied Physics and Materials Science in Caltech's Division of Engineering and Applied Science.

Decades ago, the development of so-called optical tweezers enabled scientists to move and manipulate tiny objects, like nanoparticles, using the radiative pressure from a sharply focused beam of laser light. This work formed the basis for

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Citation: Skopec R. (2019) Quantum Resourrection: Quantum Algorithm with Complex Conjugation Reverses Phases of the Wave Function Components. J Infect Dis Res, 2(1): 32-38.

the 2018 Nobel Prize in Physics. However, optical tweezers are only able to manipulate very small objects and only at very short distances.

Ognjen Ilic, postdoctoral scholar and the study's first author, gives an analogy: "One can levitate a ping pong ball using a steady stream of air from a hair dryer. But it wouldn't work if the ping pong ball were too big or if it were too far away from the hair dryer, and so on."

With this new research, objects of many different shapes and sizes—from micrometers to meters—could be manipulated with a light beam. The key is to create specific nanoscale patterns on an object's surface. This patterning interacts with light in such a way that the object can right itself when perturbed, creating a restoring torque to keep it in the light beam. Thus, rather than requiring highly focused laser beams, the objects' patterning is designed to "encode" their own stability. The light source can also be millions of miles away.

"We have come up with a method that could levitate macroscopic objects," says Atwater, who is also the director of the Joint Center for Artificial Photosynthesis. "There is an audaciously interesting application to use this technique as a means for propulsion of a new generation of spacecraft. We're a long way from actually doing that, but we are in the process of testing out the principles."

In theory, this spacecraft could be patterned with nanoscale structures and accelerated by an Earth-based laser light. Without needing to carry fuel, the spacecraft could reach very high, even relativistic speeds and possibly travel to other stars. Atwater also envisions that the technology could be used here on Earth to enable rapid manufacturing of ever-smaller objects, like circuit boards [6].

CALTECH SCIENTISTS MOVE OBJECTS USING ONLY LIGHT

The breakthrough development could lead to spacecraft without fuel. What if a spacecraft could travel through our solar system powered and accelerated using only light? That's the goal of new research coming out of Caltech.

Researchers there have developed a way to levitate and propel objects using only light, by adding specific nanoscale patterning to their surface. Scientists have the ability to move and manipulate tiny objects with the use of "optical tweezers." The tweezers move objects via the radiative pressure from a sharply focused beam of laser light. However, this impressive tool can only move small very small objects a very limited distance.

Ognjen Ilic, a postdoctoral scholar, and the study's first author give an analogy: "One can levitate a ping pong ball using a steady stream of air from a hairdryer. But it wouldn't work if the ping pong ball were too big, or if it were too far away from the hair dryer, and so on."

PRECISE PATTERN LEADS TO LEVITATION

New research is now working in ways to move objects in a range of sizes and shapes using only beams of light. The trick is to create very specific patterns on the object's surface. These nanoscale patterns interact with the light so that the object keeps 'righting' itself if disturbed so that it creates a restoring torque to keep it buoyant by the light. This means that an object can keep itself stable and not rely on highly focused beams. The patterns could even mean the light source is millions of miles away from the object.

LIGHT-BASED PROPULSION A POSSIBILITY

"We have come up with a method that could levitate macroscopic objects," says Atwater, who is also the director of the Joint Center for Artificial Photosynthesis. "There is an audaciously interesting application to use this technique as a means for propulsion of a new generation of spacecraft. We're a long way from actually doing that, but we are in the process of testing out the principles."

This research provides the conceptual theory that a spacecraft could be 'powered' through space from Earth-based laser light. The craft would not need to carry fuel allowing it to go relativistic speeds and possibly travel to other stars.

POSSIBLE APPLICATION FOR MANUFACTURING

Spacecraft that don't need fuel for propulsion would be a huge boost for the future of space-colonies. The fuel less craft could be used for intra-planet travel or as reconnaissance vehicles.

The technologies developers are also exploring ways which it could be used to enable rapid manufacturing of ever-smaller objects, like circuit boards. The research has been published in the March 18 issue of the journal Nature Photonics.

DIRECTED ENERGY WEAPONS ARE READY FOR THE SPOTLIGHT

More federal spending on directed energy weapon research and development has some stakeholders looking for operational systems to deploy in the next two or three years. The weapons — which use focused energy in the forms of lasers, microwaves and other methods against targets ranging from drone swarms to ballistic missiles — have long drawn the interest of the Department of Defense and its military services but have previously been relegated largely to the arena of the theoretical.

"It's shifted from basic education and improving awareness of where these technologies were a year or two ago, to now to begin to transition the technology to actual capabilities that can be used by U.S. warfighters," he said. "Frankly, it really is time to get on with it." Gunzinger said stakeholders attending the summit — which is now in its fifth year — used to prognosticate that directed energy technology would

be deployed to the field in the next "five to 10 years," but thanks to increased federal spending, that number may be down to two or three years.

"We are right on the cusp of fielding developmental systems that can quickly transition to operational capabilities," he said. He noted that federal spending on the research and development of the weapons systems has risen from $575 million in the President's fiscal 2017 budget to $1.1 billion two years later and $840 million in last week's budget request.

The Department of Defense plans to spend up to $235 million on directed energy capabilities alone in fiscal 2020, with interest in developing systems for air, missile and military base defense, as well as other applications. Gunzinger said the Army is working on mobile laser systems, including its High Energy Laser Tactical Vehicle Demonstrator — a 100 kW vehicle-mounted system being developed by Bethesda-based Lockheed Martin (NYSE: LMT) and Dynetics. The Navy, meanwhile, is reportedly planning to spend $299 million on laser-based defense systems in fiscal 2020, including on testing of its 150 kW laser weapon demonstrator system and a destroyer-based system that Lockheed plans to deliver that fiscal year.

"I think it's safe to say that just about all of the force providers in DoD have directed energy science and technology programs that are very close to transitioning to actual demonstrators and then operational weapons systems," he said. "That indicates the level of interest that DoD has in harnessing the power of directed energy, non-kinetic capabilities to help counter threats to American forces and our installations overseas."

So when exactly will we see these systems in the field? That depends on a number of factors — the military service, the weapons system and its delivery method — but Gunzinger said that if funding trends continue, operational systems may not be far off. "I think we are beginning to see this transition occur," he said. "With more funding being allocated to actual developmental systems that will be tested in [fiscal] 2019, 2020 and 2021 that could transition to programs to acquire them in 2022, 2023 and onward" [2].

SCIENTISTS "REVERSE TIME" WITH QUANTUM COMPUTER

They have artificially created a state that evolves in a direction opposite that of the thermodynamic arrow of time. Scientists have reversed the direction of time with a quantum computer. The breakthrough study seems to contradict basic laws of physics and could alter our understanding of the processes governing the universe. In a development that also represents a major advance in our understanding of quantum computers, by using electrons and the strange world of quantum mechanics researchers were able to turn back time in an experiment that can be likened to causing a broken rack of pool balls to go back into place.

Anyone watching the computer would see the event as if time had turned backwards. The researchers – from the Moscow Institute of Physics and Technology (MIPT) and helped by colleagues in Switzerland and the US – expect the technique to improve, becoming more reliable and precise with time.

Lead researcher Dr Gordey Lesovik, who heads the Laboratory of the Physics of Quantum Information at the MIPT, said: "We have artificially created a state that evolves in a direction opposite to that of the thermodynamic arrow of time." The "time machine" described in the journal Scientific Reports consists of a rudimentary quantum computer made up of electron "qubits". A qubit is a unit of information described by a "one", a "zero" or a mixed "superposition" of both states. In the experiment, an "evolution program" was launched which caused the qubits to become an increasingly complex changing pattern of zeros and ones. During this process, order was lost – just as it is when the pool balls are struck and scattered with a cue. But then another program modified the state of the quantum computer in such a way that it evolved "backwards", from chaos to order. It meant the state of the qubits was rewound back to its original starting point.

Most laws of physics work both ways, in the future and the past. If you see a video of a pool ball knocking into another one, for instance, and then reverse that same video, the physical processes would both make sense and it would be impossible at the level of physics to know which way around would be correct. But the universe does have one rule that goes only in one way: the second law of thermodynamics, which describes the progression from order to disorder. If you saw a video of someone breaking a perfectly arranged triangle of pool balls into a mess, for instance, then watching that backwards would obviously look non-sensical.

The new experiment is like giving the pool table such a perfectly calculated kicking that the balls rolled back into an orderly pyramid. The scientists found that, working with just two qubits, "time reversal" was achieved with a success rate of 85%. When three qubits were involved more errors occurred, resulting in a 50% success rate. The error rate is expected to drop as scientists improve the sophistication of the devices used, the researchers behind the discovery said.

The experiment could have a practical application in the development of quantum computers, the scientists said. "Our algorithm could be updated and used to test programs written for quantum computers and eliminate noise and errors," said Dr Lesovik [1].

ARROW OF TIME AND ITS REVERSAL

Uncovering the origin of the arrow of time remains a fundamental scientific challenge. Within the framework of statistical physics, this problem was inextricably associated with the Second Law of Thermodynamics, which declares that entropy growth proceeds from the system's

entanglement with the environment. It remains to be seen, however, whether the irreversibility of time is a fundamental law of nature or whether, on the contrary, it might be circumvented. Here we show that, while in nature the complex conjugation needed for time reversal is exponentially improbable, one can design a **quantum algorithm** that includes **complex conjugation** and thus **reverses a given quantum state**. Using this **algorithm** on an IBM quantum computer enables us to experimentally demonstrate **a backward time dynamics** for an electron scattered on a two-level impurity.

Decades, researchers have sought to understand how the irreversibility of the surrounding world emerges from the seemingly time-symmetric, fundamental laws of physics [1]. This question is as old as classical statistical mechanics, which itself represented an attempt to solve this enigma. Quantum mechanics stepped into the breach with two important conjectures. **The first, independently proposed by both Landau and von Neumann, postulated that the process of macroscopic measurement creates irreversibility. The second, due to Wigner, posited that time reversal operation is anti-unitary because it requires complex conjugation.** More recently, the ontological status of time-reversal symmetry of quantum mechanics as a version of probabilistic theory was discussed. Because of the requirement for complex conjugation, the universal time reversal operation lies outside the quantum realm and does not spontaneously appear in nature. The above conjectures, though crucial in their own right, nonetheless represent two different keys to the same lock. In this paper, we uncover the interrelationships between these seemingly disparate keys. It is known that dissipation is a particular case of unitary evolution accompanied by **entanglement. Entanglement, in turn, complicates quantum states by involving more and more degrees of freedom** — an increase in complexity that renders spontaneous time reversal highly improbable. Our perspective refines the Landau-von Neumann insight into irreversibility. As it turns out, the measurement process can be described as the joint unitary evolution of the quantum system and the macroscopic measuring device. **The resulting macroscopic entanglement gives rise to the insurmountable complexity of the reversal procedure.** We further show that, unexpectedly, even the evolution of single- or two-particle states in free space generates complexity that renders spontaneous time reversal either highly improbable or actually impossible. This expresses the fact that the Schrodinger equation determining evolution of quantum systems implicitly entails irreversibility — hence the arrow of time in nature.

Reversal of the spreading wave packet that in quantum mechanics in order to execute a time reversal operation one has to perform complex conjugation of the wave function, implies that the time reversal operator Tˆ is a product of a complex conjugation operator Kˆ and a unitary rotation Uˆ R, i.e., Tˆ=Uˆ R Kˆ, where for any Ψ, KˆΨ=Ψ∗. This operation not only reflects velocities like in the classical physics, but also reverses phases of the wave function components. **A general universal operation that can reverse any arbitrary wave function does not exist in nature.**

Quantum entanglement introduces the next level of complexity for **the time-reversal procedure**. Consider a two-particle state $\Psi(x_{1,}x_2)=|\Psi(x_{1,}x_2)|e^{i\varphi(x_{1,}x_2)}$ with the non-separable phase function $\varphi(x_{1,}x_2)=a_{1,}(x_1)+a_2(x_1)b_2(x_2)$. In this situation even for the non-overlapping particles with $\Psi(x_{1,}x_2)=0$ for $x_1=x_2$ the two-particle state cannot be reversed by an interaction with classical fields.

An entangled two-particle state with a non-separable phase function can naturally emerge as a result of scattering of two localized wave-packets. However, as we have seen, the generation of the time-reversed state, where a particle gets **disentangled** in the course of its forward time evolution, requires specific two-particle operations which, in general, cannot be reduced to a simple two-particle scattering [3,4].

From the above consideration one can draw important conclusions about the origin of the arrow of time:

For **the time reversal** one needs a **super system** manipulating the system in question. In the most of the cases, such a super system **cannot spontaneously emerge in nature**.

Even if such a super system would emerge for some specific situation, the corresponding **spontaneous time reversal** typically requires times exceeding the universe lifetime.

A matter-of-course super system of that kind is implemented by the so-called **universal quantum computer**. It is capable to efficiently **simulate** unitary dynamics of any physical system **endowed with local interactions (Quantum Entanglement Entropy – QEE)**. A system's state is **encoded** into the quantum state of the computer's **qubit register** and its evolution is governed by the **quantum program, a sequence of the universal quantum gates** applied to **qubit register** [7].

We must also formulate **the general principles of constructing time-reversal algorithms**.

A time-reversal operation R of the qubit register can be presented as a product $R=U_RK$ of the complex conjugation operator K, K $K(\psi_i|i\rangle)$ and some unitary operator U_R, whose form is defined by the Hamiltonian H, $U_{R=}\ U_H\ U^*_H$, $H=U_H$ diag $\{E_1\ldots E_n\}$ U_H.

It is known, that the joint transformation of the charge conjugation, parity inversion and time reversal is considered as an exact symmetry of all known laws of physics. Therefore the qubit Hamiltonian H, which corresponds to a real physical system, has to honor this symmetry well. The

unitary operation describing evolution of the physical system U is generally known and represents a transformation which is inherited from **the time-reversal symmetry of the original Hamiltonian H**.

We thus arrive at the conclusion: The number of elementary operations needed for the **exact time-reversal procedure** of the dynamics of a quantum system which on course its evolution sweeps a Hilbert space of a dimension N is bounded from above by some number O(N).

These findings break ground for investigations of the time reversal and the backward time flow in real quantum systems. One of the challenging directions to pursue, is the time dependence of reversal complexity N of an evolving quantum state. We have shown that an isolated d-dimensional quantum particle with quadratic spectrum exhibits a polynomial complexity growth $N(\tau)=\tau^d$. Uncovering the $N(\tau)$ dependence for realistic situations, accounting for the interactions will establish a mechanism and the corresponding timescale on which **time-reversed states** can **spontaneously emerge**. Another fundamentally question is whether it is possible at al design a **quantum algorithm** that would perform time-reversal more efficiently than using O(N) **elementary gates**? Above time-reversal schemes were scrolling one by one through the state components but did not exploit **quantum parallelism** in its full power.

MECHANISM OF QUANTUM METASTASES CAUSED BY THE QEE

Sporadic colon cancer is caused **predominantly by dietary factors**. We can select **bile acids** since **high levels of hydrophobic bile acids accompany a Western-style diet** and play a key role in **colon carcinogenesis**. Bile acid-induced **stresses** cause **cell death** in susceptible cells, contribute to **genomic instability** in surviving cells, **impose Darwinian selection on survivors** and **enhance initiation** and **progression to colon cancer**. The most likely **major mechanism** by which hydrophobic bile acids **induce stresses on cells is the Quantum Entanglement Entropy (QEE) metastases through the DNA damage, endoplasmic reticulum stress and mitochondrial damage**. Persistent exposure of colon epithelial cells to hydrophobic bile acids can result by **QEE** in the activation of **pro-survival stress-response pathways and the modulation of genes/proteins** associated with **chromosome maintenance** and **mitosis**. **The mechanisms** of **QEE** by which hydrophobic bile acids contribute to genomic instability include **oxidative DNA damage, p53** and **other mutations, micronuclei formation** and **aneuploidy**. Bile acids and oxidative stress **decrease DNA repair proteins**, an **increase in DNA damage** and **increased genomic instability** through this mechanism of **metastases** caused by **Quantum Entanglement Entropy**. This process provides a **mechanistic explanation** for **the important QEE link** between a **Western-style diet** and associated **increased levels of colon cancer** [8,10-12].

DICHOTOMOUS CORRELATIONS OF ADAPTATION

One prevalent description of translational medicine, first introduced by the Institute of Medicine's Clinical Research Roundtable, highlights two roadblocks (i.e., distinct areas in need of improvement): the first translational block (T1) prevents basic research findings from being tested in a clinical setting; the second translational block (T2) prevents proven interventions from becoming standard practice.

An important role in the processes of adaptation and masking in humans is playing also the immune system. The innate immune system functions as an interpreter of tissue damage and provides a first line of defense, also translates the information to other repair and defense systems in the body by stimulating angiogenesis, wound repair, and activating adaptive immunity. It is appropriate to consider autophagy a means for programmed cell survival balancing and counter-regulating apoptosis. Autophagy seems to have a dichotomous role in tumorigenesis and tumor progression.

Two other attributes play a similarly paradox role. The first involves major reprogramming of cellular energy metabolism in order to support continuous cell growth and proliferation replacing the metabolic program that operates in most normal tissues. The second involves active evasion by cancer cells from attack and elimination by immune cells. This capability highlights the dichotomous correlations of an immune system that both antagonizes and enhances tumor development and progression.

Evidence began to accumulate in the late 1990s confirming that the infiltration of neoplastic tissues by cells of the immune system serves counter-intuitively to promote tumor progression [9].

THE BIPOLAR NATURE OF TWOFACED NEW MAIN LAW OF NATURE

The quantum entanglement is a basis of twofaced reality in which we are living our lives. From this reality are outgoing also the science and healthcare too. Although **metastasis** is important for **systemic correlations expansion** (as in **tumors**). It is a highly dichotomous process, with millions of cells being required to **disseminate to allow for the selection of cells-correlates aggressive enough to survive the metastatic cascade**. To quantify the dynamics of **metastasis of correlations** development, we need look at **the coincidences of metastases** in terms of **co-occurrence** at every point of time. To quantify co-occurrence we can use **the φ-correlation between dichotomous variables** defined as:

$$\frac{N_X(t)C_{ij}(t) - m_i(t)m_j(t)}{\sqrt{m_i(t)m_j(t)\left[N_X(t) - m_i(t)\right]\left[N_X(t) - m_j(t)\right]}}$$

where $C_{ij}(t)$ is the number of co-occurrence at time t. than i and j represent particular site of metastasis, X represents the primary correlations type. **The pair-wise correlations (coincidences) between metastasis network links** for every primary correlations types and lead to **the correlation coefficient matrix**.

The dichotomous correlations of the adaptation may be caused also by **the Quantum Entanglement Relative Entropy** as a measure of distinguishability between two quantum states in the same Hilbert space. The relative entropy of two density matrices p_0 and p_1 is defined as $S(p_1|p_0) = tr(p_1 \log p_1) - tr(p_1 \log p_0)$. When p_0 and p_1 are reduced density matrices on a spatial domain D for two states of a quantum field theory (QFT), implies that $S(p_1|p_0)$ increases with the size of D. Than $\Delta S_{EE} = -tr(p_1 \log p_1) + tr(p_0 \log p_0)$ is **the change in entanglement entropy across D as one goes between the states**.

When the states under comparison are close, the positivity is saturated to leading order: $S(p_1|p_0) = \Delta\langle H_{\text{mod}}\rangle - \Delta S_{EE} = 0$ [8].

The problem of conventional adaptation may be given by a definition of static, deterministic world. **The proliferative correlations lead to the resonances between the degrees of freedom**. When we increase the value of energy, we **increase the regions where randomness prevails**. For some critical value of energy, chaos appears: over time we observe the exponential divergence of neighboring trajectories. For fully developed chaos, **the cloud of points** generated by a trajectory leads to diffusion. Here we must as first formulate a **new Main Natural Law: the HYBRID Quantum Entanglement Entropy (HQEE)** [9]. **Through above resonances the QEE is causing a metastasis of correlations, antagonistically intertwining (coincidences) all types of potentially conflicting interests in cancer**.

CONCLUSION

Knowledge of recent neuorobiology is proving our thesis that Charles Darwin was wrong when formulated his theorem Survival of the fittest. It was the biggest false myth of the modern science. As we have demonstrated in our above study, the careerist is psychopath and not the fittest. From this reason we must to correct Charles Darwin to Survival of the careerist. Reality in 21st century is showing that Survival of the careerist based on the Quantum Entanglement Entropy (QEE) is more valid principle of Social Dynamics in our days. Careerist Competition is the main cause of the QEE leading to increased complications through the Quantum Coincidences of Social Dynamics. But the Mankind can be resurrected! Quantum Resurrection is possible through the Quantum Algorithm With Complex Conjugation which Reverses Phases of the Wave Function Components [7,13].

ACKNOWLEDGMENT

The author reports no competing interests. This work was supported by Dr. Marta Ballová, Ing. Jozef Balla, Ing. Konrad Balla and Livuska Ballová.

CONFLICT OF INTERESTS DISCLOSURE

The author declares no conflict of interests.

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