Quantum computing is incompatible with Born Rule and the related measurement postulates, the qubit reading capability is falsified experimentally, and the Feynman-Deutsch quantum computing theory is low-strict, low-testable and infeasible.

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Research Article

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Abstract

(1) Deutsch stated: it is shown that quantum theory and the 'universal quantum computer' are compatible with the principle, that is, it is shown the compatibility of quantum computing with quantum mechanics. Born Rule and Time Evolution Postulate are the important ingredients of quantum theory. Deutsch et al. did not provide a proof of the compatibility of quantum computing with Born Rule (and Time Evolution Postulate), avoided the extraction of unitary transformation results in their papers, and defaulted that the output probability density can map to the observation-space CS_C and to be read. We attribute the proof of the incompatibility of quantum computing with quantum mechanics to the proof of the incompatibility of quantum computing with Born Rule. The basic form of Born Rule is that $|\psi|^2$ represents the probability density for particles; if the system is in a state $|\psi\rangle$, then the probability that the eigenvalue λ_i of Q is found when Q is measured is $P(\lambda_i) = \left|\left\langle \lambda_n \middle| \psi \right\rangle\right|^2$. We show that in the technical scheme of quantum computing, there is an imposed strong constraint on Born Rule, that is, double $|\psi|^2$ hypothesis (i.e., Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis), which requires that there is such a mapping from the state-space CS_M to the observation-space CS_C: $\left|\psi_M\right|^2 \rightarrow \left|\psi_C\right|^2$, where $\left|\psi_M\right|^2$is the probability density of the wavefunction $a|0\rangle + b|1\rangle$ of the single-qubit, $\left|\psi_C\right|^2$ is the probability density of the corresponding outcomes within CS_C, and $\left|\psi_C\right|^2$ is equivalent to $\left|\psi_M\right|^2$. The original Born Rule does not assert the mapping $\left|\psi_M\right|^2 \rightarrow \left|\psi_C\right|^2$. We demonstrate that in the technical scheme of quantum computing it is assumed that the single-qubit carrier-symbol snapshot traceability is the basis for the realization of the double $|\psi|^2$. We, using the Stern-Gerlach experiment and the chip engineer's contraction mapping experiment, experimentally falsify the single-qubit carrier-symbol snapshot traceability, and thus experimentally falsify the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis. In this way, we show that quantum computing is incompatible with Born Rule and the related measurement postulates, and the Feynman-Deutsch quantum computing theory is not feasible. The principal error of the Feynman-Deutsch theory is the mapping $\left|\psi_M\right|^2 \rightarrow \left|\psi_C\right|^2$; the root of all errors in quantum computing is the double probability density hidden in the technical scheme, which is the false Born Rule. (2) The Feynman-Deutsch theory is a low-strict, low-testable and non-transparent theory for the following reasons: postulate-level assumptions are hidden in the technical scheme; the testability (falsifiability) of various parts of quantum computing has never been publicized. It has long been believed that quantum computing centers on unitary transformation sequence. We show that qubit reading is the only falsifiable part of quantum computing. Because falsifiable issue takes precedence over unfalsifiable issue, and principle-level issue takes precedence over non-principle-level issue, the priority of quantum computing research is the inapplicability of Born Rule to quantum computing rather than the applicability of unitary transformation. i.e., the real heart of quantum computing is the existence of $|\psi|^2$ mapping from CS_M to CS_C. We prove the fact that although algorithm and the algorithm's output within CS_M are carried out in the name of quantum technology, the "double $|\psi|^2$" is actually independent of Born Rule, and independent

of quantum mechanics. The methodological error of the Feynman-Deutsch theory is to exclude the inapplicability of Born Rule from the research field. (3) We re-examined the effectiveness of three published quantum computing (Shor factoring) experiments, and show that they are invalid in the sense of falsifiability criterion and the traversal criterion. The high risk of the infeasibility of quantum computing is completely underestimated. (4) In the last sections, we examine a topic with a higher degree of generality: the traceability (direction non-constraint) of single-particle information process. Using the "reproducible effect" method suggested by Popper, we show that the realization of quantum computing violates human's existing knowledge about the contraction mapping experiments of two spaces. The proofs in this paper show that the compression mapping experiment in meso-micro scale and the physical version of Gödel's incompleteness theorem are more profound principles of quantum physics (including Born Rule and the related measurement postulates).

1 Introduction

1.1 Deutsch confirmed that he had proved the compatibility of quantum computing with quantum mechanics. As long as the incompatibility of quantum computing with Born Rule is proved, the compatibility of quantum computing with quantum mechanics does not hold, and quantum computing is not a real branch of quantum mechanics.

Deutsch [1] stated: it is shown that quantum theory and the 'universal quantum computer' are compatible with the principle. That is, Deutsch confirmed that he had proved the compatibility of quantum computing with quantum mechanics. It is believed that the compatibility of quantum computing with quantum mechanics has been proven and thus quantum computing is believed to be a branch of quantum mechanics. The main ingredients of quantum theory are Bohr's atom model, Heisenberg's uncertainty relations, Born Rule (wavefunction measurement), Schrödinger's time evolution equation, and de Broglie's matter wave. Born Rule specifies the relation between wavefunction and measurement, and there are three postulates related to Born Rule in quantum mechanics textbooks. In fact, Deutsch did not provide a proof of the compatibility of quantum computation with Born Rule and a precise proof of the compatibility of quantum computation with Time Evolution Postulate; he only proved the compatibility of quantum computation with the theory of operators on Hilbert space, which is the mathematical basis of quantum mechanics. This paper re-examines the compatibility of quantum computing with Born Rule and the compatibility of quantum computing with Time Evolution Postulate. For reasons that will be mentioned in the Section 1.2, this paper focuses on the incompatibility of quantum computing with Born Rule. As long as the incompatibility of quantum computing with Born Rule and the related measurement postulates is proved, the compatibility of quantum computing with quantum mechanics does not hold, and quantum computing is not a real branch of quantum mechanics.

We call the existing mainstream quantum computing theory the Feynman-Deutsch quantum computing theory (the Feynman-Deutsch theory for short). Feynman [2], in 1982, proposed the idea of quantum computing. Deutsch, in 1985, provided an explicit model of the quantum computation, i.e., the quantum Turing machine, which is decisive for the development of quantum computing. Bernstein and Vazirani [3] studied the computational complexity. Shor [4, 5] proposed an algorithm for factoring numbers on a quantum computer in 1994. The physicists mentioned above (including Benioff [6]) are the main contributors to theoretical quantum computer (i.e., theoretical scheme of quantum computing). DiVincenzo [7], as one of the main contributors to practical quantum computer (i.e., technical scheme of quantum computing), proposed feasibility criteria for quantum computing in 2000. The reason for distinguishing between theoretical and technical schemes for quantum computing is that the most fundamental principles of quantum computing are hidden in the technical schemes (see Sections 1.3 and 1.4). In the past 20 years, many publications have claimed to have experimentally implemented multi-bit quantum computation. However, the effectiveness of these computing devices has not been fully verified, and quantum factoring algorithms for quantum computers have not made significant progress in the past 20 years. Feynman's 1982 paper, Deutsch's 1985 paper, Shor's 1995 papers and DiVincenzo's 2000 paper are the most cited articles in the field of quantum computing. The boom in quantum computing papers and increased investment in quantum computing research indicate that most physicists have accepted Deutsch's proof of the compatibility of quantum computing with quantum mechanics, and that the DiVincenzo criteria (including his technical scheme) have no major deficiencies.

The purpose of this paper is not in an exploratory way to investigate the theoretical foundations of quantum computing, but in a way of logic and experimental verification, to show that the mainstream quantum computing theory (the Feynman-Deutsch theory) is a theory with low-strictness, low testability and low transparency, and is an infeasible theory, and to show that quantum computing is not compatible with Born Rule and the related measurement postulates.

1.2 Quantum computing theory is a low-strict and non-transparent theory. The non-transparency is related to two self-protection mechanisms. The Feynman-Deutsch theory is an almost sure unfalsifiable theory experimentally, an Achilles theory.

The resistance to questioning the compatibility of quantum computing with quantum mechanics comes from the lack of the strictness and transparency of quantum computing. In fact, the lack of the strictness in quantum computing is beyond imagination. From a scientist's standpoint, a strict theory of quantum computing must satisfy the following conditions. (a) It expresses the basic assumptions (principles) and the definition of the basic elements (i.e., qubits) in an explicit form, and important principles cannot be implicit in the theoretical and technical schemes. (b) It expresses the testability (falsifiability) of the individual ingredients of the theory. (c) If a principle given by the theory has not been thoroughly tested experimentally, it must be made public. We will show in later sections that the Feynman-Deutsch theory falls far short of satisfying any of the above three requirements. All these requirements involve transparency of the theory, which means that one can express link path from theoretical statement to underlying principle; namely, for the tree structure of quantum computing, all root nodes and their links to child nodes are visible.

This paper criticizes the non-transparency of quantum computing theory, which is directly related to two self-protection mechanisms implicit in quantum computing theory that impede insight into the incompatibility of quantum computing with quantum mechanics. The first self-protection mechanism is Achilles mechanism (unfalsifiability mechanism), which is innate to quantum computing theory. The second self-protection mechanism is the strategic-hiding mechanism, which is artificial and is a bad mechanism. In order to make quantum computing transparent, these two self-protection mechanisms must be made public. We first publicize the Achilles mechanism (the unfalsifiability mechanism).

God's to God, Caesar's to Caesar. For the core topic of this paper - the incompatibility of quantum computing with Born Rule, we have to do two things. First, falsifiable things belong to falsifiable, unfalsifiable things belong to non-falsifiable. Second, Born Rule' things belong to Born Rule, quantum computing's things belong to quantum computing. Deutsch cited Popper's statement in his paper that "The usual criterion for the empirical status of a theory is that it be experimentally falsifiable (Popper 1959)." Is quantum computing a normal falsifiable theory? Is each of the basic ingredients of quantum computing falsifiable? In particular, is the time evolution hypothesis of quantum computing a falsifiable theory, and is the qubit reading governed by Born Rule a falsifiable theory? Let us examine the falsifiability (testability) of the Feynman-Deutsch theory. The basic hypothesis of quantum computing must be testable. For the testability of quantum computing, Deutsch gave the most important statement of quantum computing (called Deutsch's testability statement): Q must not be observed before the computation has ended since this would, in general, alter its relative state. Shor stated: by the Heisenberg uncertainty principle, looking at the machine during the computation will disturb the rest of the computation. In this way, the authors of the Feynman-Deutsch theory divided quantum computing into two parts: the part in the presence of observation (i.e., measurement or qubit reading) and the part in the absence of observation (i.e., computation process). There is no experimental falsification without observation. Therefore, the computation process before the end of the computation is unfalsifiable experimentally, and only the qubit reading is falsifiable. Similar to the mathematical concept of almost sure convergence, a theory describing the physical process is called almost sure unfalsifiable theory or Achilles theory, if it meets the following two conditions: (a) The entire history is unobservable before the output is read, only the output reading is observable. (b) The testability of any physical occurrence before reading output is boiled down to the testability of reading the output. The degree of universality and of precision of a theory increases with its degree of falsifiability (Popper 1959). The Feynman-Deutsch theory is an almost sure unfalsifiable theory experimentally, and is a theory with lowest degree of the testability and of precision in physics. It is important to emphasize that the quantum computing theory is the only example of Achilles theory in the history of physics.

The falsifiability feature of quantum computing theory actually generates a self-protection mechanism (called Achilles mechanism or unfalsifiability mechanism). Let's explain the Achilles mechanism. The Greek hero Achilles is invulnerable everywhere but his heel. We must distinguish the falsifiable part of the Feynman-Deutsch theory. The entire quantum computing built from qubits consists of three basic ingredients: qubits preparation, unitary transformation sequence (hereafter abbreviated as u-transformation sequence or algorithm step), qubit reading (collapse-conversion-reading, i.e., the bits collapse, the collapse information is converted to readable data, and the probability output is read). The quantum computing is cleverly designed as an Achilles-like theory that is unfalsifiable anywhere except the final glimpse – measurement. The Achilles mechanism of quantum computing means that for the u-transformation sequence, any auxiliary hypothesis made by the designer cannot be falsified by falsifiers as long as the designer does not make logical mistakes, because the part in the absence of observation is unfalsifiable experimentally. The Achilles mechanism provides an umbrella for the non-quantum factors of quantum computing.

Publicizing the Achilles mechanism improves the transparency of quantum computing. This transparency tells us the following two things. (1) The time evolution specified by the u-transformation sequence belongs to the unfalsifiable part, and the relevant auxiliary assumptions are protected by the Achilles mechanism, that is, they cannot be falsified experimentally. As a result, it is hopeless for the falsifier to try to falsify the time evolution specified by the u-transformation sequence. (2) Born Rule rules the collapse-conversion-reading, which belongs to the falsifiable part. Therefore, we have to focus on the incompatibility of quantum computing with Born Rule.

1.3 Principle-level assumption hidden in technical scheme: DiVincenzo's "negligible overlap" hypothesis. Turing's term "scanned symbol" is treated as taboo and is erased in quantum computing theory. Quantum computing theory must honor the anti-deterministic nature of quantum mechanics.

To make quantum computing theory transparent, we must publicize the second self-protection mechanism hidden in quantum computing theory, strategic-hiding mechanism. The "strategic-hiding mechanism" means to make new assertions about things that the postulates of quantum mechanics cannot assert, and to hide the new assertions in technical scheme. The benefit to the falsifiers of publicizing this strategic-hiding mechanism is that the transparency allows them to see the root node in the tree structure of quantum computing hidden in the technical scheme, which will be the decisive factor in proving the incompatibility of quantum computing with Born Rule.

We now give an example to demonstrate the non-transparency of quantum computing theory, that is, to show how a principle-level statement, which involves time evolution, can be hidden in technical solution. We focus on a surprising fact that the Feynman-Deutsch theory taboos Turing's term "scanned symbol". Deutsch called quantum computer quantum Turing machine and used many terms of Turing machine. Turing highlighted the term "scanned symbol" when defining a computer in his paper. Turing [8] stated: "The 'scanned symbol' is the only one of which the machine is, so to speak, 'directly aware'." "…the possible behavior of the machine at any moment is determined by the configuration and the scanned symbol." On the other hand, we should pay attention to the following facts. In the 1980s, Deutsch admitted that scanning was a component of quantum computers in his paper, but only the word "scanned tape location" appeared and the "scanned symbol" did not appear in his paper. In the 1990s and 2000s, DiVincenzo and Shor's papers basically did not use the concept of "scanned symbol". The ban on non-zero-life scanned symbols is a non-transparent move of the authors of quantum computation theory. Let's make their move transparent. We examine practical quantum computer. We consider the three reported quantum computing experiments of Shor's quantum factoring algorithm, which are denoted by A [9] (molecular quantum computing), B [10] and C [11] (optical quantum computing). (Note that we present the disproof of the feasibility of these quantum computing experiments in Section 8.) We focus on the single-bit traversal in the unitary-by-unitary sequence that specifies quantum algorithm. All quantum computing experiments can be expressed via quantum circuit diagrams. Figure 1a demonstrates that these three quantum computing experiments can be explicitly decomposed into single-bit entry-to-exit traversals. We have to ask: In a single-bit entry-to-exit traversal, is there a certain time interval accompanied by the deterministic behavior of single bit? Let us recall Turing's theory how deals with a single step of computation. According Turing's theory, a single step in a computation is specified by a quadruple of the form (current state, scanned symbol, machine turns on action and then turn off, new state). The term “scanned symbol” means the existence and uniqueness of the coupling symbol, and is a decisive term. The u-transformation sequence formulated by the Feynman-Deutsch theory is: turn on H_1 and then turn off, turn on H_2 and then turn off, etc. That formulation erases the coupling symbol between the two transformations. Let us decompose the classical and quantum circuits in order to analyze the basic elements of the single-bit entry-to-exit traversal, especially the "scanned symbol" involved in the coupling. In the circuit diagrams of a classical computer exhibited in Fig. 1b, there are two types of fundamental elements: action-segments and symbol gaps. We decompose the process shown in the first line of Fig. 1b into seven steps (see the lower part of Fig. 1b): symbol gap, operation-segment, symbol gap, and so on. The implementation of the gate and the non-zero-life symbol gap (signal trace) is supported by classical physics. The situation is completely different in quantum computing. As shown in the upper part of Fig. 1a, in the reported experiment A, there are three types of fundamental elements: operation-segments, symbol gaps and collapse glimpse (we consider only the first two elements in the unfalsifiable part). The path of object k can be divided into nine steps: five symbol gaps and four operation-segments (two Hadamard operations and two editing actions). The two-state object k is in a single eigenstate within symbol gaps s_1 and s_3 and a superposition state within symbol gap s_2. We call symbol gap s_1 (s_3) the trapping-eigenstate gap and s_2 the superposition-state gap. In symbol gap s_3 the control qubits are marked by filled circles. Symbol gap s_6 is the sum of all outputs. All the symbol gaps are finally divided into two categories: trapping superposition-state gaps and trapping-eigenstate gaps. As a result, the decisive elements of quantum computing are operation-segments, superposition-state gaps and trapping-eigenstate gaps. In this way, the real quantum computing circuits demonstrate that in the Feynman-Deutsch theory people make a surprising assumption: while the operation-segment is specified as a time evolution in a finite time interval, the symbol gap characterizing the coupling is specified as a process with infinitesimal time interval (i.e., zero-life gap). In Turing's theory a single bit undergoes a sequence of operations: operation → “coupling symbol” → operation → “coupling symbol” →…. Our question is: Why is the keyword “coupling symbol” required by Turing's theory deleted in quantum computing?

In fact, all symbols except the input and output symbols are the coupling symbols bored by the bits between the two transformations. The coupling symbols (i.e., scanned symbols) are the building blocks that make up the configuration and even the computing machine. The uniqueness of coupling symbol ensures that in each step the coupling symbols are completely determined by the configuration. Supposing that the machine turns off the first action at time t_1 and turns on the second action at time t_2, then the symbol pointed $S(t_2)$ to by the print head is exactly the outgoing symbol $S(t_1)$ at the instant of turning off the first action (see the upper part of Fig. 1c). In other words, at moment t ($t_1 \leq t \leq t_2$) the snapshots of the symbols obtained by the machine are all the same. To illustrate the theoretical motivation of the Feynman-Deutsch theory to prohibit non-zero-life scanned symbol, we consider a scanned-symbol time gap paradox as follows.

Scanned-symbol time-gap paradox

We suppose that there is a quantum algorithm supported by the Feynman-Deutsch theory. For "scanned symbol" of a given qubit in the time interval ($t_1 \leq t \leq t_2$), we are faced with the following two opposite propositions. (a) The uniqueness of coupling symbol requires that $S(t_1) = S(t_2)$, which implies the existence of a deterministic motion of eigenstate symbol of single-bit in the time gap between two transformations. Then, an unacceptable consequence is that if the single-bit motion violates the "anti-determinism principle", then this quantum algorithm succeeds. (b) If the single-bit motion obeys the anti-determinism principle, then $S(t_2) = S(t_1)$ is undecidable, that is, the uniqueness of coupled symbol is destroyed and this quantum algorithm fails.

This paradox shows that it is a dilemma to accept the non-zero-life scanned symbol and the deterministic behavior of a single bit. However, it is a consensus in physics not to accept single-bit deterministic behavior. We can be confident that the theoretical motivation of the Feynman-Deutsch theory to prohibit non-zero-life scanned symbol is to exclude the deterministic behavior of a single qubit. The essential difference between classical and quantum computer is that the symbol gaps and action-segments, in classical computers, are non-zero life ones. In fact, in modern computers, for the connection between two transistors in a chip, people can provide on-site or off-site evidence of non-zero-life coupling symbol. It is puzzling that for 40 years people have never associated the zero-life scanned symbol with the elimination of single bit's deterministic behavior.

We examine how Deutsch and DiVincenzo deal with the zero-life coupling symbol. Deutsch stated in his paper: “Turing machines, in other words, are those quantum computers whose dynamics ensure that they remain in a computational basis state at the end of each step, given that they start in one.” Deutsch theoretically stipulates that the dynamics begin at the beginning of each step, and end at the end of each step. Thus, Deutsch in a non-transparent way expressed that the symbol gap between the two actions should be a zero-life gap. However, Deutsch's statement does not imply a final decision on the lifetime of the coupling symbol. It is DiVincenzo, the physicist who handles the practical quantum computer, really decides the lifetime of the coupled symbol. DiVincenzo, in his technical solution, explicitly stated: “…like the laser power that can be concentrated on a particular ion. Given these various constraints, the ‘clock time’ of the quantum computer will be determined by the time interval needed such that two consecutive pulses have negligible overlap.” We call the above assumption hidden in the technical scheme the DiVincenzo "negligible overlap" hypothesis (or zero-life-gap hypothesis). In order to ensure that the symbol gap is made into a zero-life gap, “clock time” is assigned only to the unitary transformations not to symbol gaps. DiVincenzo wrote: “…the physical apparatus should be designed so that H_1 can be turned on from time 0 to time t, then turned off and H_2 turned on from time t to time 2t, etc.” In DiVincenzo’s technical scheme (see Fig. 1c), the coupling symbol is simplified as zero-life symbol; the whole timeline is filled with non-zero life action-segments, and the trapping-eigenstate gap between the two pulses is not allowed.

“Non-zero-life trapping-eigenstate gap for single-particle” means the predictability of the behavior of the single-particle, that is, that the observer traps the single-particle in his device so that the single-particle is in the eigenstate ϕ_n for a sustainable amount of time. The term “trapping-eigenstate” theoretically mean that a single eigenvector of the single-particle system is separated from the orthogonal basis of the state space in a non-probabilistic manner. The predictability of single-particles is one of the biggest threats to quantum computing theory. To erase the theoretical existence of coupling symbol in the definition of quantum computer is a major event, and shows that the Feynman-Deutsch theory has a lower degree of strictness (including a low degree of transparency) than expected. From this example we conclude: (1) The Feynman-Deutsch theory is incomplete and cannot cover all the fundamental principles in practical quantum computers. Specifically, for the tree structure of quantum computing, DiVincenzo's technical scheme (DiVincenzo criteria) occupies more root nodes than Deutsch's abstract computing theory. (2) The danger of the non-transparency of quantum computing theory should never be underestimated. Only transparency can make us see the relationship between the negligible overlap hidden in the technical scheme and the root node (anti-determinism principle and Time Evolution Postulate).

1.4 Why are principle-level assumptions hidden in technical schemes? Quantum computing is the only branch of quantum mechanics with zero distance from quantum measurement axioms since the establishment of quantum mechanics. The tree structure of quantum computing theory is incomplete and non-transparent.

The DiVincenzo's "negligible overlap” hypothesis (i.e., zero-life-gap hypothesis), as a principle-level assumption, alters the convention of coupling symbols in the definition of quantum computer, but is unconsciously packaged as a quantum technology. The strategic-hiding mechanism implied in quantum computing theory allows new assertions hidden in technical schemes to be made about matters that cannot be asserted by quantum mechanics postulates. The worst possibility cannot be ruled out: the new assertions hidden in the technical scheme tamper with the roots of the quantum mechanics tree structure (Born Rule and the related three measurement postulates and Time Evolution Postulate), but deal with relevant matters in the name of the quantum mechanics postulates (Fig. 2). In response to the above criticism, one would argue that other branches of quantum technology not related to quantum computing have not received similar criticism, so why would quantum computing receive such criticism? Our answer is that quantum computing is the only branch of quantum mechanics with zero distance from quantum measurement axioms since the establishment of quantum mechanics. We call statements that are zero-distance from the quantum axioms (directly associated with the clauses of the quantum axioms) as root node statements. The root-node statement of Deutsch's abstract quantum computing theory is poor because it eschews details involving Born Rule and Time Evolution Postulate. However, DiVincenzo's scheme has to deal with these details using the root node statements. We provide two examples as follows. (a) Collapse Postulate is a measurement postulate related to Born Rule. Its simple form is: Actual measurement of a physical observable carries over the state vector of the system into the eigenvector $\left|\lambda_{\mathrm{n}}\right\rangle$ belonging to the observed eigenvalue λ_n of the measured observable. Collapse Postulate does not assert whether the system remembers the state $\left|\lambda_{\mathrm{n}}\right\rangle$ for finite time intervals. DiVincenzo stated in his technical scheme: "If the measurement is "non-demolition", that is, if in addition to reporting outcome "0" the measurement leaves the qubit in state $|0\rangle\langle 0|$, then it can also be used for the state preparation of requirement 2…" DiVincenzo's formulation implies that the qubit can remember the state $|0\rangle\langle 0|$ until the next time the machine is turned on again. Note that the states $|0\rangle\langle 0|$ are generated by computational processes and measurement and do not directly originate from the initial state. In this way, DiVincenzo's technical scheme customizes the measurement postulate and is at zero distance from the quantum measurement axiom, while Deutsch's abstract quantum computation theory remains at a distance from the quantum measurement axiom. (b) Born Rule is directly related to the measurement postulate, for which a simple form is: If the system is in the state $|\psi\rangle$, then the probability that a measurement of A gives eigenvalue λ_n is P(λ_n)= $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$. DiVincenzo in his technical scheme directly corresponds the eigenvalue λ_n of the qubit to the outcome provided by the instrument, stating that: the measurement should give outcome "0" with probability p and "1" with probability 1 − p. in this way DiVincenzo's technical scheme, which assumes double probability density for single-qubit, modifies the measurement postulate (see Section 4 for further explanation). The above discussion leads us to an interesting finding: Among the leading authors of quantum computing theory, authors who study theoretical quantum computer focus entirely on the unfalsifiable part of quantum computing, especially the unitary transformation and the u-transformation sequence; On the other hand, only the authors working on practical quantum computers (mainly the physicist DiVincenzo) offer technical schemes for the falsifiable part (qubit reading).

The examination of the transparency of quantum computing theory leads us to the conclusion that the Feynman-Deutsch theory is far from being a rigorous theory and that its tree structure is incomplete and non-transparent (see Fig. 2); the theoretical scheme of quantum computing is not the whole of the tree structure of quantum computing, and the root nodes related to Born Rule and Time Evolution Postulate are hidden in the technical scheme. Hiding the root of the quantum computing tree structure by means of non-transparency is the biggest deficiency of quantum computing theory.

1.5 The main purpose and the underlying idea of this paper. Compatibility of quantum computing with quantum mechanics (compatibility of quantum computing with Born Rule) does not hold. Quantum computing is not based on real quantum mechanics described by the mainstream textbooks. The Feynman-Deutsch quantum computing theory is not feasible.

(1) The main purpose of this paper is to prove that quantum computing is incompatible with Born Rule and the related measurement postulates. The five key terms for the proof are: falsifiable part of quantum computing, Born Rule (including the related measurement postulates), the Feynman-Deutsch's $|\psi|^2$

(double) reading hypothesis (double probability density hypothesis), and the single-qubit carrier-symbol snapshot traceability.

(2) The underlying idea of this paper is to prove that the compatibility of quantum computing with quantum mechanics (compatibility of quantum computing with Born Rule) does not hold by the following steps. (a) As a preparation for the proof, we point out the methodological errors in quantum computing research. We distinguish the falsifiable part and the unfalsifiable part of quantum computing. In quantum computing, only qubit reading step is falsifiable, and should be governed by Born Rule and related measurement postulates. A falsifiable issue takes precedence over an unfalsifiable issue, and a principle-level issue takes precedence over a non-principle-level issue. Therefore, the priority of quantum computing research is the inapplicability of Born Rule to quantum computing rather than the applicability of unitary transformation and error correction. The methodological error of the Feynman-Deutsch theory is to exclude the inapplicability of Born Rule (as the priority) from the research field. (b) The basic form of Born Rule is that $|\psi|^2$ (i.e., the square of the magnitude of the particle's wavefunction at that point) represents the probability density for particles; if the system is in a state $|\psi\rangle$, then the probability that the eigenvalue λ_i of Q is found when Q is measured is $P(\lambda_i) = \left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$. The collapse and finding eigenvalue λ_i occur in micro-observer's coordinate system (henceforth referred to as the state-space coordinate system); the human-readable outputs are described in the current coordinate system (henceforth referred to as the observation-space coordinate system). For simplicity, we denote the micro-observer's state-space coordinate system and the human observer's observation-space coordinate system as CS_M and CS_C, respectively. We show that in the technical scheme of quantum computing, there is an imposed strong constraint on Born Rule, that is, the double probability density hypothesis (or double $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$ hypothesis or $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$ mapping hypothesis). Note that double probability density is sometimes abbreviated as double $|\psi|^2$ or $|\psi|^2$ mapping. The double $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$ hypothesis requires that there is such a mapping from CS_M to CS_C: $\left|\psi_M\right|^2 \rightarrow \left|\psi_C\right|^2$, where $\left|\psi_M\right|^2 = \left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$ for the single-qubit, $\left|\psi_C\right|^2$ is the probability density of the corresponding outcomes within CS_C, and $\left|\psi_C\right|^2$ is equivalent to $\left|\psi_M\right|^2$. In other words, our first step is to show that Feynman-Deutsch's qubit reading hypothesis is the double probability density hypothesis hidden in the technical scheme (including the single-qubit carrier-symbol snapshot traceability). (c) Our second step is to prove that Born Rule and the related measurement postulates are not applicable to quantum computing, and that quantum computing is incompatible with Born Rule and the related measurement postulates. (d) Our third step is to prove that the Feynman-Deutsch's qubit reading hypothesis violates quantum mechanics, and is a non-quantum mechanical assumption. We experimentally falsify the single-qubit carrier-symbol snapshot traceability, and falsify the double probability density hypothesis, so we falsify the Feynman-Deutsch's qubit reading hypothesis. Specifically, we prove that the qubit reading required by quantum computing cannot be compatible with quantum mechanics. We have reached an unexpected conclusion: the Feynman-Deutsch theory is a theory with the low degree of strictness and the lowest degree of falsifiability; quantum

computing is not based on real quantum mechanics described by the mainstream textbooks, but on custom-built quantum mechanics; quantum computing is infeasible. It must be emphasized that the double $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$ assumption, which introduces a traceable correspondence between the coordinate systems CS_M and CS_C in an explicit form, violates the most fundamental ideas of quantum mechanics. Introducing mapping $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$ is an unacceptable principal mistake. Due to the incompatibility of quantum computing with Born Rule and the related measurement postulates, the Feynman-Deutsch theory does not qualify as a branch of quantum mechanics.

(3) We show that the DiVincenzo criteria are unreasonable because it focuses only on the secondary criteria (qubits scalability, set of transformations, etc.), and completely ignores the decisive criterion of the falsifiable part. We show that the quantum computing (Shor factoring) experiments that are valid in the sense of the DiVincenzo criteria are invalid in the sense of the high-authority implementation criteria. We present a crucial experiment for quantum computing implementation: the single-qubit Postulate IV (Born) experiment.

(4) The traceability of natural processes is the top-level issues in a discipline of physics. We relate the realization of qubit reading to a high-level falsifiability question: the falsification of the single-particle information-process traceability. This paper will reveal the dependence of quantum computing on the direction of the quantum information process between two coordinate systems, which means that there is a physics version of Gödel's incompleteness theorem (see Section 11).

2 Methods/experimental

(1) The quantum computing theory must be based on unbiased observation and systematic experimentation. Unbiased observation requires intellectual honesty, and systematic experiment requires refuting "self-evident". "The scientist's first claim will always be intellectual honesty…" (Heisenberg) [12]. For the design of experiments, we put intellectual honesty at the forefront. The purpose of this paper is to prove that quantum computing is incompatible with Born Rule. Intellectual honesty is decisive for ruling whether the technical scheme of quantum computing modifies the original Born Rule. Intellectual honesty is decisive for ruling whether there is a testable double probability density for reading single-qubit. For the above-mentioned ruling, there is no need for complex mathematical derivations, nor the design of new and ingenious experiments, only for intellectual honesty. The assumption of qubit reading (the Feynman-Deutsch's qubit reading rule) introduced in quantum computing is not self-evident and should be based on unbiased observation and systematic experimentation. This article will show that human contraction mapping experiments are adjudicative for the falsification of quantum computing theory. From a methodological point of view, the unacceptable fact is that self-evident clauses are used in algorithm step and measurement step in quantum computing. Born Rule is replaced by the self-evident clause "double probability density $\left|\left\langle\lambda_n\middle|\psi\right\rangle\right|^2$". The Feynman-Deutsch theory lacks rigorous definitions of elementary elements (e.g., transmission of single-qubit collapse information and single-qubit reuse), and the related

falsifiability and feasibility have been not discussed. Attention has been focused on complexity, error correction, etc. We check the falsifiability of the main parts of quantum computing. We refute the implicit "self-evident" in the algorithm step and qubit-reading step.

(3) Shor's papers are the most cited articles in the field of quantum computing. The Shor algorithm is generally believed to be the most suitable quantum algorithm to demonstrate a quantum step forward in quantum computing. We choose three reported quantum computing experiments (Experiment A [9] is a molecular quantum computing experiment, experiments B [10] and C [11] are optical quantum computing experiments) that are representative of the full range of quantum computing experiments (Shor factoring) and prove that for each experiment, the implementation of quantum computing is invalid. We present a crucial experiment for quantum computing implementation: the single-qubit postulate (Born Rule) IV experiment.

(4) In Section 9, we will discuss the relevance between quantum computing and the undecidability of information process of single quantum object. We use the falsification method (reproducible effect of traceability refutation) suggested by Popper to falsify the single-particle information-process traceability. We give the following three types of reproducible effect of reversibility refutation for quantum experiments (mathematical modeling): experiments involving quantum ensembles, experiments involving individual particles of a quantum field, and experiments involving a single trapped quantum system.

3 Born Rule And The Related Measurement Postulates Formulated By Quantum Mechanics Textbooks, Feynman-deutsch's |ψ|2 (Double) Reading Hypothesis (Feynman-deutsch Version Of Born Rule).

For proving the incompatibility of quantum computing with Born Rule, the following three requirements are necessary. (1) Give the formulation of Born Rule and the related measurement postulates, which must be statements that are generally accepted by mainstream quantum mechanics textbooks. (2) Give the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis (i.e., the Feynman-Deutsch version of Born Rule), which must be clauses generally accepted by the main authors of the Feynman-Deutsch theory. (3) Give the qubit definition. Since there are no generally accepted textbooks on quantum computing to date, the clauses of the qubit definition must be the clauses that are generally accepted by the main authors of the Feynman-Deutsch theory.

3.1 The formulation of Born Rule and the related measurement postulates.

Born Rule is related to mainstream quantum postulates, which specifies eigenvalue measurements. The mainstream quantum postulates refer to the principles of quantum mechanics listed in the mainstream quantum mechanics textbooks, such as the seven postulates given by C. Cohen-Tannoudji et al [13], the six postulates given by Y. Peleg et al [14]. Born Rule is associated with three postulates for eigenvalue measurement, namely postulates III, IV and V expressed by C. Cohen-Tannoudji et al (or expressed by Y.

Peleg et al). In the u-transformation sequence the time evolution of single-qubit must obey Time Evolution Postulate, i.e., Postulate ▯ expressed by C. Cohen-Tannoudji et al (or expressed by Y. Peleg et al). Born's probability density rule comes from Born's speech on his rule: “Again an idea of Einstein's gave me the lead. He had tried to make the duality of particles - light quanta or photons - and waves comprehensible by interpreting the square of the optical wave amplitudes as probability density for the occurrence of photons. This concept could at once be carried over to the psi-function: $|\psi|^2$ ought to represent the probability density for electrons (or other particles) (Born 1954).” From now on, we understand the term "Born Rule" as Born's probability density rule plus Postulate IV, and the generalized Born Rule as Born Rule and the related measurement postulates.

Born Rule: (1) Born’s probability density rule: the square of the magnitude of the wavefunction describes the probability that a micro-object with wave-particle duality will be found at a particular position and time per unit length within the state-space coordinate system. (2) Postulate ▯ (eigenvalue measurement Postulate ▯): if the system is in a state $|\psi\rangle$, then the probability P that the eigenvalue λ_i of is found when Q is measured is $\left|\left\langle \lambda_i \middle| \psi \right\rangle\right|^2$.

Born Rule (Generalized Born Rule): (1) Born’s probability density rule. (2) Postulate ▯ (eigenvalue measurement Postulate ▯). (3) Postulate III (eigenvalue measurement Postulate III): the only possible result of the measurement of a physical quantity Q is one of the eigenvalues of the corresponding observable . (4) Postulate ▯ (Collapse Postulate ▯): if the measurement of the physical quantity Q on the system in the state $|\psi\rangle$ gives the result λ_n, the state of the system immediately after the measurement is $\left|\lambda_n\right\rangle$.

3.2 The Feynman-Deutsch’s $|\psi|^2$(double) reading hypothesis (the Feynman-Deutsch version of Born Rule).

The Feynman-Deutsch theory is such a quantum computing theory that based on the papers of Feynman, Deutsch, Shor, DiVincenzo et al. Born Rule is the quantum mechanical principle that rules eigenvalue measurement and probability reading. Confusingly, the term "Born Rule" did not appear in the original papers of Feynman, Deutsch, Benioff, Bernstein & Vazirani, Shor and DiVincenzo. The term "Born Rule" occasionally appears in the writings of proponents of quantum computing in unclear ways. The real reason why the main authors of quantum computing theory are collectively silent on Born Rule is unknown. It may be a possible reason that the authors consider the qubit reading belongs to the technical scheme, that is, the qubit-reading belongs to the category of actual quantum computer. DiVincenzo is the only physicist among the main authors of quantum computing who makes a statement about the qubit reading. Since the other authors did not dispute the DiVincenzo's criteria, DiVincenzo's fifth criterion involving qubit reading should be regarded as "a term generally accepted by authors of quantum computing theory." We refer to the assumptions about the qubit reading based on the DiVincenzo criteria as the Feynman-Deutsch’s $|\psi|^2$(double) reading hypothesis (i.e., the Feynman-Deutsch version of Born Rule), and its exact form will be given in Section 4.5.

The qubit reading involves two coordinate systems CS_M and CS_C. The essential distinction between Born Rule and the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis is that single-qubit reading requires double probability density assumption, and the double probability density assumption requires the single-qubit carrier-symbol snapshot traceability and the dependence of the probability density to the frequency of repeated occurrence of single-qubit (see the next sections for further discussion).

3.3 The definition of qubit.

The three essentials of Turing's original bit, in Turing's 1936 paper, are: scanned square, scanned symbol and operation. Turing wrote: "At any moment there is just one square, say the r-th, bearing the symbol S(r) which is 'in the machine'. We may call this square the 'scanned square'. The symbol on the scanned square may be called the 'scanned symbol'." Turing defines operations as the behavior of the machine to change symbols. When describing quantum Turing machine, Benioff and Bernstein-Vazirani wrote "scanned square" as "cell". In this paper, we use "carrier-cell" instead of "cell (square)". Turing's bit is defined as a binary (R, S(R)), the carrier-cell R wearing symbol S(R), where R, S(R) and U satisfy specific requirements about the relationships between R, S(R) and U. The basic features of these relationships are inherited by the qubit definition.

Definition of qubit: **The three essentials of qubit are carrier-cell R, symbol (i.e., state symbol) S(R) and operation (transformation) U. A qubit is a binary (R, S(R)), where R, S(R) and U satisfy the following requirements. (a) Relationship between carrier-cell and symbol.** A qubit is a two-state quantum system; the symbol S(R) worn by a carrier-cell R is one of $|0\rangle$,$|1\rangle$ **and** $a|0\rangle + b|1\rangle$. **(b) Relationship between carrier-cells.** The set of carrier-cells {R_j} is a finite set (j ∈ Z), where Z is the set of integers from 1 to N. The carrier-cells satisfy the following spatial-temporal independency of carrier-location. For the two carrier-cells R_1 and R_2 that do not involve joint operations (R_1 and R_2 are equivalent to two spatially isolated squares on the tape), under ideal conditions, the following physical interference is prohibited: R_1 is a part of R_2 in a probabilistic superposition manner (including the prohibition of the special phase relationship between R_1 and R_2 that changes the symbols $S(R_1)$ and $S(R_2)$). For the same carrier-cell R, under ideal conditions, the self-interference is prohibited. **(c) Relationship between carrier-cell and operation (called action property).** Operation is an action applied by the machine to a carrier-cell wearing the symbol, the operation may change the symbol worn by the carrier-cell at the instant of turning on the action to the symbol worn by the carrier-cell at the instant of turning off the action. The operation does not change the carrier-cell. The operation can be zero-life or non-zero-life. **(d) Relationship between two operations (called gap property).** We call a carrier-cell wearing the symbol a gap of the qubit, if this carrier-cell is between two operations. For a gap wearing a symbol, neither the carrier-cell nor the symbol will automatically disappear or change until the next action. In particular, for two successive operations the outgoing symbol is equal to the subsequent incoming symbol. The gap of the qubit can be zero-life or non-zero-life.

The above qubit definition provides the details of the properties of qubits. Turing in 1936 did not need to write details such as "neither the carrier-cell nor the symbol will automatically disappear or change until the next action". However, this detail can be destructive to quantum computing (see Section 1.3). The above basic requirements of the qubit definition are generally accepted by the main authors of the Feynman-Deutsch theory (including Deutsch, Benioff, Bernstein & Vazirani, Shor). Deutsch wrote: “The universal quantum computer Q has all the properties of T …” “…Corresponding to Turing’s ‘tape position’ is another observable \hat {x}, which has the whole of Z as its spectrum. The observable \hat {x} is the ‘address’ number of the currently scanned tape location.” Benioff wrote: “T is an infinite array of cells where each cell can assume any one of a finite number of states in S, the tape symbol alphabet.” Bernstein and Vazirani wrote: “The QTM has a two-way infinite tape of cells indexed by Z and a single read/write tape head that moves along the tape.” Shor wrote: “in a quantum Turing machine, a basis state is defined by what is written on the tape and by the position and state of the head.” As soon as they accept Turing's carrier-cell idea, they accept the four requirements in the qubit definition. An unacceptable oversight in quantum computing theory is the failure to verify whether the spatial-temporal independency of the carrier-location makes qubits have non-wave characteristics.

4 Quantum Computing Is Incompatible With Born Rule And The Related Measurement Postulates. Born Rule Is Not Applicable To Quantum Computing. The Feynman-deutsch’s |ψ|2(Double) Reading Hypothesis Is Hidden In The Technical Scheme.

4.1 The demarcation criterion between Born Rule and the Feynman-Deutsch’s $|\psi|^2$(double) reading hypothesis is the double probability density. The original Born Rule does not assert the double probability density for two coordinate systems.

For proving the incompatibility of quantum computing with Born Rule, the difficulty we face is the non-transparency of quantum computing theory. Feynman and Deutsch et al. make no statement at all about the applicability of Born Rule to quantum computing in their theoretical schemes, and have not seriously discussed the measurement process of $|\psi|^2$. The transparent qubit reading requires us to find the Feynman-Deutsch’s $|\psi|^2$ reading hypothesis (i.e., the Feynman-Deutsch version of Born Rule) hidden in the technical scheme, and to find the demarcation criterion between Born Rule and the Feynman-Deutsch’s $|\psi|^2$ reading hypothesis, which must involve the relationship between $|\psi|^2$ and measurement. The imposed strong constraint of quantum computing theory on $|\psi|^2$ is hidden in an inconspicuous manner in the technical scheme provided by the DiVincenzo criteria. The Feynman-Deutsch’s $|\psi|^2$(double) reading hypothesis is based on DiVincenzo's fifth criterion (A qubit-specific measurement capability), and its main parts are as follows.

“Finally, the result of a computation must be read out, and this requires the ability to measure specific qubits. In an ideal measurement, if a qubit’s density matrix is $\rho = \mathrm{p}|0\rangle\langle 0| + (1-p)|1\rangle\langle 1| + \alpha|0\rangle\langle 1| + \alpha^*|1\rangle\langle 0|$, the measurement should give outcome “0” with probability p and “1” with probability 1-p independent of α and of any other parameters of the system, including the state of nearby qubits, and without changing the state of the rest of the quantum computer. If the measurement is “non-demolition”, that is, if in addition to reporting outcome “0” the measurement leaves the qubit in state $|0\rangle\langle 0|$, then it can also be used for the state preparation of requirement 2; but requirement 2 can be fulfilled in other ways."

To obtain the demarcation criterion between Born Rule and the Feynman-Deutsch's $|\psi|^2$ reading hypothesis, we apply Born Rule and DiVincenzo's fifth criterion to an electron system and a single qubit, respectively, and examine the difference between the two applications. For the electron system the probability distribution given by $|\psi|^2$ can be interpreted as electron cloud (i.e., electron waves). For a hydrogen atom, there is an electron cloud (electron waves) within CS_M expressed by the probability density for the occurrence of electrons with wave-particle duality; at the same time, Born Rule does not assert the existence of another electron cloud expressed indirectly by the measurement outcomes within CS_C. However, for a single qubit, according to DiVincenzo's fifth criterion, there is not only the probability density $\left|\psi_M\right|^2$describing the occurrence of the qubit within CS_M, but also the probability density $\left|\psi_C\right|^2$ given by the probabilities of measurement outcomes "0" and "1" within CS_C. In other words, DiVincenzo's fifth criterion specifies two mathematically equivalent qubit clouds: the qubit cloud expressed by the probability density $\left|\psi_M\right|^2$ for the qubit within CS_M, which consists of the eigenvalue-snapshots 0 and 1: the qubit cloud expressed by the probability density $\left|\psi_C\right|^2$ for the outcomes within CS_C, which consists of two mathematical points 0 and 1. Importantly, the qubit cloud consisting of outcomes expressed by $\left|\psi_C\right|^2$ is a physical reality recognized by quantum computing theory, not a virtual concept.

We now have attributed "the difference between the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis and Born Rule" to the fact that there is double probability density for quantum computing, and the original Born Rule does not assert the double probability density for two coordinate systems CS_M and CS_C. In this way, we obtain the key concept for proving the incompatibility of quantum computing with Born Rule, i.e., the demarcation criterion between Born Rule and the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis: the double probability density (double $|\psi|^2$ or $|\psi|^2$ mapping for short). It must be noted that the fact that Deutsch et al. avoid the extraction of unitary transformation results in their paper should be understood as their default mapping $\left|\psi_M\right|^2 \rightarrow \left|\psi_C\right|^2$.

4.2 The implementation of the double probability density requires the single-qubit carrier-symbol snapshot traceability, which is hidden in the technical scheme of quantum computing.

The double probability density hypothesis naturally raises a question: for the two equivalent qubit clouds, is there a one-to-one correspondence between the readable labels (i.e. measurement outcomes) within CS_C and the eigenvalue snapshots of the qubits within CS_M. This question involves traceability of the eigenvalue snapshot, and we need a definition of traceability. In quantum computing, if a readable label (i.e., sign outcome) within CS_C corresponds to a single qubit (carrier-cell) among the N bits within CS_M, we call this readable label (or this single qubit) single-qubit traceable. If the readable label corresponds not only to a specified single qubit (carrier-cell), but also corresponds to the single-eigenstate-symbol label (0 or 1) worn by that carrier-cell, we call this readable label (or this single qubit) single-qubit carrier-symbol snapshot traceable. Note that the term "single-qubit carrier-symbol snapshot traceability" means the dual traceability of both a single carrier and a single symbol snapshot. In explaining the probability amplitude, Feynman [15], in his lecture, described the electron experiment with waves and bullets. In the electronic experiment with bullets, the bullets come in lump without interference and there exists a traceable mapping path. In the electron experiment with waves, it is impossible to trace readable label back to individual electron emitted from the source due to interference effects. the difference between the electron cloud and the qubit cloud depends on a fact that Born Rule and the electron cloud do not involve the traceability, the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis and the qubit cloud contain the traceability. It must be emphasized that if both the carrier and the symbol can be traced back, then the probability of outcomes can be traced back to the probability of the distinguishable carrier-cells, that is, the single-bit carrier-symbol snapshot traceability is a sufficient condition for the realization of double probability density.

We have to show that the DiVincenzo criteria implies the single-qubit carrier-symbol snapshot traceability, and that the single-qubit carrier-symbol snapshot traceability hidden in the technical schemes of quantum computing is "a term generally accepted by authors of quantum computing theory". Again, DiVincenzo is the only physicist among the main authors of quantum computing who makes a statement about the double $|\psi|^2$. Since the other authors did not dispute DiVincenzo's criteria, DiVincenzo's criteria involving the double probability should be regarded as "a term generally accepted by authors of quantum computing theory."

From the reasoning of the DiVincenzo criteria, it is not difficult to obtain the following three important results.

(1) DiVincenzo's fifth criterion implies the single-bit traceability, since the outcome “0” and “1” correspond to the specified single qubit. The correspondence between the outcome and the specified qubit means that a readable label within CS_C can be traced back to a single qubit within CS_M. In fact, the following facts show that researchers in quantum computing generally accept the single-bit traceability. (a) It is believed that the distinguishability of 2^N states of N-qubit makes quantum computers potentially millions of times more powerful than conventional computers. Without single-bit traceability, it is impossible to have distinguishability of 2^N quantum states for N-bit. Rather, single-bit traceability and the single-qubit carrier-symbol snapshot traceability are actually the fundamental belief of quantum computing: there is no quantum computer without the distinguishability of 2^N quantum states for N-bit. (b) The single-bit traceability has been implied in the technical schemes of quantum computing. In the quantum circuit (e.g., quantum computing experiment A, see Fig. 1), it is recognized that the collapse information of a single bit is received by an independent device. (c) According to the qubit definition (spatial independency of carrier-location), for N collapsed qubits, in an ideal measurement, the mapping path of single-bit must be separable from the mapping path of N bits.

(2) The single-bit zeroing-reuse probability mechanism implied in the DiVincenzo criteria. DiVincenzo stated: "…reporting outcome "0" the measurement leaves the qubit in state $|0\rangle\langle 0|$, then it can also be used for the state preparation of requirement 2…" His statement means that the "outcome 0" is not only traceable to a single eigenstate of the qubit, but also allows the qubit to rest for a time period in this eigenstate. For "the need for a continuous supply of 0s,", DiVincenzo said: "the speed with which a qubit can be zeroed will eventually be a very important issue…. the quantum computer will have to equipped with some kind of 'qubit conveyor belt' …initialized while on the "belt", then brought back to the active place after the initialization is finished." We examine the zeroing of qubits. In order to get the outcomes, the apparatus is designed so that the computation is started from time t_1, then the first outcome is obtained and the qubit is zeroed; and the computation is started from time t_2, then the second outcome is obtained and the qubit is zeroed, etc. We make the above statements about probability mechanism transparent, and expose an important hypothesis implied in the DiVincenzo criteria: the single-bit zeroing-reuse probability mechanism, according with which the quantum probability is dependent of the frequency of recurrence of a single carrier-cell with the same properties within CS_M.

(3) DiVincenzo's fifth criterion implies the single-qubit carrier-symbol snapshot traceability. Our reasoning based on the DiVincenzo's technical scheme is as follows. (a) DiVincenzo's statement "the qubit in state $|0\rangle\langle 0|$ can also be used for the state preparation" means that at least some outcomes among all reporting outcomes can be traced back to single-state symbols (e.g., state $|0\rangle\langle 0|$); and that the collapse snapshot of the qubit can rest for a time period. That is, the reporting outcome "0" within CS_C corresponds to a single carrier-cell within CS_M that wears the state symbol "0". (b) DiVincenzo's statement about "0 state qubits on a conveyor" actually admits the existence of trapped state $|0\rangle$. Clearly, DiVincenzo's statements avoids the traceability of the state $|1\rangle\langle 1|$ and the existence of trapped state $|1\rangle$. However, the existence of a single qubit with the state symbol "1" has been accepted by the researchers of quantum computing. For example, in the quantum computing experiment A, the initial state of the bits is $|0000001\rangle$. That is, there exists the seventh qubit with the state symbol "1". (c) According to the qubit definition, qubit has the spatial-temporal independency of tape-location, and the external effects of changing the state symbol worn by the carrier-cell are only unitary transformation, measurement (collapse) and decoherence. Quantum computing theory assumes that for a collapsed qubit, within decoherence time, other quantum states of the qubit cannot play a role. The collapse snapshot "0" (or "1") of the qubit should not be changed within the decoherence time. (d) For DiVincenzo's statement that "outcome "0" with probability p and "1" with probability 1-p", there are logically two possible forms of the double probability density. The first form is the double probability density with the single-qubit carrier-symbol snapshot traceability. That is, the probability that an outcome "0" is traceable to a qubit being in $|0\rangle$ is close to 100%. The second form is the double probability density without the single-qubit carrier-symbol snapshot traceability. An example is that the sequence of outcomes within CS_C is completely different from the sequence of collapse snapshots of the qubit within CS_M, say, the outcome sequence and the snapshot sequence are 0, 1, 1, 0, 1, ... and 1, 0, 0, 1, 1, ..., respectively; but the statistics ultimately show that the probability of getting "0" is p. For the completeness of the theory, we should not assume that for states$|0\rangle\langle 0|$ (or even $|1\rangle\langle 1|$) there is single-qubit carrier-symbol snapshot traceability; for other states there is no single-qubit carrier-symbol snapshot traceability. Thus, the second form of the double probability density is illogical.

As a result, the conclusion of our reasoning is that in the technical schemes accepted by the main authors of the Feynman-Deutsch theory a radical principle is actually hidden: for the double $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$, a readable label can always be traced back to a specified qubit, and to a specified single-eigenvalue snapshot, and there is the single-bit zeroing-reuse probability mechanism.

4.3 Quantum computing is incompatible with Born Rule, and Born Rule is not applicable to quantum computing.

(1) Born's probability density rule is not applicable to quantum computing for the following three reasons. (a) Born's probability density rule specifies that $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$ represents the probability density for matter waves within the state-space coordinate system CS_M, and does not assert that there is an equivalent probability density described by the corresponding outcomes within the observation-space coordinate system CS_C. Therefore, the Born's probability density rule is not applicable to quantum computing that requires the double $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$. (b) Born's probability density rule does not contain any assertions about the zeroing and reuse of single-carrier wearing eigenvalue-snapshot. Quantum mechanics does not rule out the traceability of some microscopic carriers. For example, we can trace the outcome within CS_C to certain atoms and molecules within CS_M. However, for microscopic carriers with pure wave nature (such as photon and electron), Born's rule does not assert that $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$ represents the probability density generated by the repeated occurrence of the same carrier wearing different eigenvalue-snapshots. As Feynman said, an electron behaves behave "sometimes like a particle and sometimes like a wave". The snapshot of the carrier named "electron" may be a superposition of the snapshots of the carriers corresponding to other outcomes. For example, for an electron cloud of a hydrogen atom, no quantum mechanics textbook asserts that the electron cloud (electron waves) is such a statistical effect that the same electron-carrier appears repeatedly in space similar to the same carrier-cell appears repeatedly in space. However, quantum computing theory asserts that the qubit cloud is such a statistical effect that the same carrier named "carrier-cell" appears repeatedly in space in a non-wave manner. Thus, there is a conflict between Born Rule and quantum computing theory for the interpretation of $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$. (c) Born's probability density rule does not make any assertions about the single-qubit carrier-symbol snapshot traceability (dual traceability of both a single eigenvalue-snapshot and single eigenvalue-carrier snapshot).

(2) We examine the relationship between eigenvalue-measurement Postulate and the double $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$ (including the single-qubit carrier-symbol snapshot traceability). In quantum computing, Postulate IV is applied to measurements in this way: if the system is in state $|\psi\rangle$=a$|0\rangle + b|1\rangle$, then the probability P(0)

(or P(1)) that the eigenvalue 0 (or 1) is found when the qubit is measured is P(0) = $\left|\psi_0\right|^2$=$|\langle 0|\psi\rangle|^2$ (or P(1)=$\left|\psi_1\right|^2$=$|\langle 1|\psi\rangle|^2$). On the surface, there seems to be the applicability of Postulate IV to the wavefunction a$|0\rangle + b|1\rangle$, but in fact this is not the case. Postulate IV does not support the double $\left|\left\langle \lambda_i\right|\psi\rangle\right|^2$, that is, does not support that the probabilities $|\langle 0|\psi\rangle|^2$ and $|\langle 1|\psi\rangle|^2$ can map to the observation-space coordinate system CS_C. We pointed out in Section 4.2 that if there is a double $\left|\left\langle \lambda_i\right|\psi\rangle\right|^2$, then there are two possible forms: with the single-bit carrier-symbol snapshot traceability or without the single-bit carrier-symbol snapshot traceability. Quantum computing theory has chosen to impose a strong constraint on Postulate IV: the double $\left|\left\langle \lambda_i\right|\psi\rangle\right|^2$ with single-bit carrier-symbol snapshot traceability. Therefore, we conclude that the probabilities P(0)=$|\langle 0|\psi\rangle|^2$ and P(1)=$|\langle 1|\psi\rangle|^2$ specified by quantum computing theory, which is applicable to outcomes within CS_C, is not a special case of Postulate IV, and that Postulate IV is not applicable to quantum computing.

As a result, our conclusion is that quantum computing is incompatible with Born Rule, and Born Rule is not applicable to quantum computing that requires the double $\left|\left\langle \lambda_i\right|\psi\rangle\right|^2$.

4.4 Quantum computing is incompatible with Postulates III and V, and Postulates III and V are not applicable to quantum computing.

We examine the compatibility of quantum computing with eigenvalue-measurement Postulate III and Collapse Postulate V (see Section 3.1).

(1) We examine the relationship between eigenvalue-measurement Postulates III and the double $|\psi|^2$ (including the single-qubit carrier-symbol snapshot traceability). Postulate III states "The only possible result of the measurement of a physical quantity Q is one of the eigenvalues of the corresponding observable.", and means that one measurement makes an eigenvalue-snapshot of the corresponding observable to exist within CS_M. However, the single-qubit carrier-symbol snapshot traceability required by quantum computing theory asserts that one measurement makes an eigenvalue-snapshot of the corresponding observable to exist within CS_M, and the eigenvalue-snapshot corresponds to the corresponding outcome within CS_C. Based on intellectual honesty (see Section 2.1), we conclude that the above assertion of quantum computation theory cannot be a special case of Postulate III. Therefore, the eigenvalue-measurement Postulate III is not applicable to quantum computation.

(3) We examine the relationship between Collapse Postulate Ⅴ and the double $\left|\left\langle \lambda_i\right|\psi\rangle\right|^2$ (including the single-qubit carrier-symbol snapshot traceability). First, Collapse Postulate V asserts that a measurement carries over the state vector of the system into the eigenvector belonging to the corresponding observed eigenvalue, but does not assert that the eigenvalue snapshot can be traced from the outcome in the coordinate system CS_C. Second, Collapse Postulate V states that if the measurement of the physical

quantity Q on the system in the state $|\psi\rangle$ gives the result λ_n, the state of the system immediately after the measurement is $\left|\lambda_n\right\rangle$. Note that the state $|\psi\rangle$ is a superposition state. No quantum mechanics textbook asserts that the following statement is a special case of Postulate V: if the measurement for a qubit in the state $|0\rangle$ gives the result 0, the state of the system immediately after the measurement is $|0\rangle$, and the eigenstate $|0\rangle$ can rest for a period of time. However, in the technical scheme of quantum computing it is assumed that the eigenvalue snapshot can be traced from the outcome within CS_C, and that the memory of the collapsed eigenstate being in $|0\rangle$ can be maintained for a period of time. Therefore, we conclude that the carrier-eigenvalue snapshot traceability and the eigenvalue snapshot with memory specified by quantum computing theory are beyond the jurisdiction of Postulate V, and Postulate V is not applicable to quantum computing.

Now, it is shown that quantum computing is incompatible with Born Rule, and is incompatible with the related postulates III and V.

4.5 We have successfully made the qubit reading fully transparent. Quantum computing

We have managed to make the qubit reading as the most transparent ingredient of quantum computing. The qubit reading step is divided into three transparent parts. **(1) Transparent double** $|\psi|^2$. (a) Qubit reading (N-qubit reading) ultimately boils down to reading single-qubit wavefunction ψ_{bit}=a$|0\rangle + b|1\rangle$. In this way, reading two-dimensional vector ψ_{bit} has become the simplest concept in quantum computing theory. (b) Reading $\psi_{\text{bit}}$is related to the double $\left|\psi_{bit}\right|^2$. Quantum computing specifies two equivalent qubit clouds: an eigenvalue cloud within CS_M and an outcome cloud within CS_C. (2) **Transparent traceability.** For dual $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$, there are two possible mapping paths involving the single-qubit carrier-symbol snapshot traceability. In quantum computing theory people choose the double $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$with the single-qubit carrier-symbol snapshot traceability hidden in the technical scheme, excluding the double $\left|\left\langle\lambda_i\middle|\psi\right\rangle\right|^2$ without the single-qubit carrier-symbol snapshot traceability. (3) **Transparent probability mechanism.** For quantum computing there are two options of probability mechanism. First, the probability described by $|\psi|^2$ is generated by qubit ensemble. Second, the probability described by $|\psi|^2$ is dependent of the frequency of repeated occurrence of single-qubit. In quantum computing theory people choose the second probability mechanism.

Transparency allows us to see that in the Feynman-Deutsch theory Born Rule has been tampered with, the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis (i.e., the Feynman-Deutsch version of Born Rule), a new rule governing the qubit reading, is introduced. We express the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis, which is based on DiVincenzo's fifth criterion, as follows.

Feynman-Deutsch's (double) reading hypothesis

(1) If the quantum system is a system of micro-particles (electrons, atoms, or other particles) rather than an N-bit system as described by quantum computing, then the form of Born Rule is as described in mainstream quantum mechanics textbooks. (2) If the quantum system is an N-bit system described by quantum computing, then the qubit reading satisfies the following conditions. (a) The probability density is subject to a strong constraint, double probability density. $\left|\left\langle \lambda_i \middle| \psi\right\rangle\right|^2$ represents the probability density for the repeated occurrence of single-qubit with eigenvalue snapshot within CS_M, and also represents the probability density for the repeated occurrence of the corresponding outcome within CS_C. (b) The Born's probability density rule, Postulates III, IV and V is subject to a strong constraint, the single-qubit carrier-symbol snapshot traceability. (c) The probability described by $\left|\left\langle \lambda_i \middle| \psi\right\rangle\right|^2$ is dependent of the frequency of repeated occurrence of single-qubit.

Remark

(1) For the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis, we have not introduced any new theory. We have only revealed the postulate-level assumptions–the double probability density, the single-qubit carrier-symbol snapshot traceability and probability mechanism, which are hidden in the technical schemes of the Feynman-Deutsch theory. (2) The transparency of qubit reading is a turning point in the development of quantum computing. Our proof shows that the $|\psi|^2$(double) reading hypothesis (the double $|\psi|^2$ hypothesis) is a postulate-level assumption outside quantum mechanical system. For the past forty years, the leading authors of quantum computing theory have denied the existence of postulate-level assumption outside quantum mechanical system in their theory.

The single-qubit carrier-symbol snapshot traceability is equivalent to the reversibility of single-qubit collapse snapshot, which relates to the efficiency of transmission of single-qubit collapsed snapshot. We define reversibility of single-qubit collapse snapshot as an information process that satisfies the following two conditions. (1) Immediately after the measurement there is binary information of the single-qubit (bit-snapshot, state-symbol-snapshot) within CS_M; (2) The binary information (bit-snapshot, state-symbol-snapshot), in an ideal measurement, is transmitted to CS_C with information conversion efficiency of 1, and converted into binary information (observation-carrier information, observation-label information) within CS_C. "Information conversion efficiency of 1" means that there is no information dissipation in the information process from CS_M to CS_C. The term "information conversion efficiency" is associated with the term "fidelity of single qubit output". For the fidelity of single bit output, DiVincenzo stated: "Such an ideal measurement as I have described is said to have 100% quantum efficiency; real measurements always have less.… in the absence of any other imperfections, a computation with a single-bit output … will have 90% reliability." DiVincenzo did not give the exact and transparent form of the fidelity of "single-qubit output". In the sense of transparent double probability density, DiVincenzo's ideal fidelity of single-qubit collapse information is actually equivalent to the single-qubit carrier-symbol snapshot traceability.

5 The Single-qubit Carrier-symbol Snapshot Traceability Is Falsified, The Qubit Reading Capability (The Feynman-deutsch's |ψ|2(Double) Reading Hypothesis) Is Falsified.

5.1 Methodological basis for the falsification of the single-qubit reading capability. the falsification experiment for the double $|\psi|^2$ and the falsification experiment for intrinsic fixed point.

We are confronted with a possible defense: although Born Rule is not applicable to quantum computing, yet the Feynman-Deutsch's $|\psi|^2$(qubit) reading hypothesis can be compatible with quantum mechanics, so quantum computing and quantum mechanics could be still compatible in the end. In other words, proponents of quantum computing hope for the possibility that the Feynman-Deutsch's $|\psi|^2$(qubit) reading hypothesis can bypass Born Rule and is compatible with quantum mechanics. We must deny such a possibility. Therefore, for the proof of the incompatibility of quantum computing with quantum mechanics, an additional proof is needed, namely the experimental falsification of the Feynman-Deutsch's $|\psi|^2$(qubit) reading hypothesis. We need a methodological basis for the falsification of the single-particle information-process traceability. Popper provides such a basis when he stated the falsification of a theory: "The fourth and final step is the testing of a theory by the empirical application of the conclusions derived from it. … If the conclusion is shown to be false, then this is taken as a signal that the theory cannot be completely correct (logically the theory is falsified) … (Popper)". Our falsification target is the single-qubit reading capability expressed by DiVincenzo's fifth criterion, that is, the Feynman-Deutsch's $|\psi|^2$(double) reading hypothesis. Due to the transparency of the falsifiable part of quantum computing, this falsification target can be reduced to the double probability density and ultimately to the single-qubit carrier-symbol snapshot traceability.

We will use two kinds of test experiments to falsify the single-qubit carrier-symbol snapshot traceability. The first test experiment is the falsification experiment for the double $|\psi|^2$, which directly falsifies the single-qubit carrier-symbol snapshot traceability. The second test experiment is the falsification experiment for intrinsic fixed point (see Section 5.3). In order to ensure the legitimacy of the test experiments, we require that the corresponding test experiments cannot be refuted. This means that the test experiments are generally accepted experiments. We will use the Stern-Gerlach experiment and chip-engineer's contraction mapping experiments as test experiments.

5.2 Experimental falsification of the single-qubit reading capability (1): The Stern-Gerlach experiment is an ensemble collapse experiment, and is also a falsification experiment for the dual traceability of both single eigenvalue-snapshot and single eigenvalue-carrier-snapshot.

The Stern-Gerlach experiment (S-G experiment for short) [16] is one of the greatest experiments in the history of quantum physics. Feynman [15] stated that the S-G experiment can serve as a prototype for the description of all quantum phenomena. The S-G experiment involves eigenvalue measurements of individual atoms in an atomic beam and the mapping path between the coordinate system CS_M and CS_C, can serve as a prototype for the description of eigenvalue measurements. In fact, atoms as two-state quantum objects, in the S-G experiment, can be considered as qubits. The S-G experiment characterizes the conversion of the carrier-eigenvalue information of a large number of two-state quantum objects. We will show that the Stern-Gerlach experiment falsifies the single-qubit carrier-symbol snapshot traceability, that is, falsifies the dual traceability of both a single eigenvalue-snapshot and single eigenvalue-carrier-snapshot.

There are two types of S-G experiments. (1) In the original experiment, a beam of silver atoms from an oven is directed through a magnetic field and finally falls onto a glass slide, where it exhibits traces of splitting. (2) In the S-G (potassium) experiment (with potassium atoms instead of silver atoms), a beam of potassium atoms ultimately produces a bimodal distribution of a dot signal on the screen of an ionization detector (Fig. 3b). The following two points must be emphasized. First, we are concerned only with the spatial process between the final states of the atoms and the current observation-label carriers. Second, the information of the collapsed atoms is obtained from the observation-label carriers (dot signals on an ionization detector), but is not obtained directly from the atomic spins. As shown in Fig. 3c, the correspondence between the final states of the atoms and the observation-label carriers is related to the following spatial regions: the microspatial channel β and the spatial channel in the depth direction (the state-to-observation spatial channel). Let us compare the spatial channels in differential geometry with the state-to-observation spatial channel. As shown in Fig. 3a, to express the relevance between the intrinsic geometry of a surface and the external geometry, the mathematical concepts that geometers face are: the projections of the geodesics onto the tangent plane, the one-to-one mapping between the two geometries, the connection path, the compatibility between the two coordinate systems and coordinate transformations. For the single-qubit carrier-symbol snapshot traceability in the state-to-observation space channel, the relevant mathematical concepts are: one-to-one mapping, the mapping path and the connectedness between the two spaces; the relevant basic physical question are: is the correspondence between CS_M and CS_C the correspondence between the state-label carriers (silver or potassium atoms) and the observation-label carriers (signals on the detector screen)? Can an observation-label carrier be traced back to a single state-label carrier? Can single-eigenvalue snapshot traceability and single-eigenvalue-carrier snapshots traceability be achieved simultaneously?

In the S-G (potassium) experiment, the correspondence between the spin atoms (state-label carriers) and dot signals (observation-label carriers) on the ionization detector screen is achieved by means of ionization and avalanching. We trace this correspondence to the processes in the two channels. The potassium atoms that have collapsed to their final states, $|\uparrow\rangle$ or $|\downarrow\rangle$, reach the entrance of the detector in the microspatial channel and interact with the particles of the detector medium. Finally, by means of ionization and avalanche processes, readable labels (i.e., signals) on the detector screen are produced. The potassium atom in the microspatial channel has no causal orbital. on the other hand, and there is no one-to-one correspondence within the ionization and avalanche processes. As shown in Fig. 3c, suppose that there is a signal W within the detector after ionization and avalanche. We ask, can the signal W be traced back to a single collapsed atom A at position x? Can the collapsed atom A at position x be traced back to a single atom A at the source S? According to quantum mechanics, as Feynman stated, there is only the amplitude that an atom goes from the source S to position x, that is, there is no single-atom traceability. Similarly, due to ionization and avalanches, there is only a probability that an atom goes from the position x to the signal W. There is no single-atom traceability, and no single-eigenvalue-snapshot traceability. The superposition state allows an atom to appear instantaneously anywhere in the microspatial channel. The atoms have wave-particle duality and undergo ionization and avalanche. Similar to the double slit experiment, there are several possibilities: the same observation-label carrier can be traced to several atoms, and several observation-label carriers can be traced to the same atom.

Let's examine the traceability of such a single atom A_0 that is not disturbed by other atoms in the S-G experiment. According to Collapse Postulate (Postulate V), the measurement makes A_0 collapse into state $|\uparrow\rangle$ (that is, the eigenvalue-snapshot for A_0 is ↑), and induces ionization and avalanche. Collapse Postulate does not assert that the collapsed eigenstate is a trapping eigenstate. That is, Collapse Postulate does not assert that the atom that is in the collapsed eigenstate are not allowed to "reorient" (as Feynman said, the atom A_0 does not remember that it was in a state $|\uparrow\rangle$ when it collapsed). Importantly, the measurement is not a zero-life process. The atom A_0 can collapse again, goes into state $|\downarrow\rangle$ or $|\uparrow\rangle$, and induces new ionization and avalanche. In this way, even for an isolated atom, it is impossible to trace the eigenvalue snapshot of the atom A_0 within CS_M from the observation-label W within CS_C. Similar to the S-G (potassium) experiment, in the original S-G experiment, the silver atoms with wave-particle duality interact with other atoms to produce the observation-label carriers (i.e., visible deposited silver particles). There is no the traceability from the eigenvalue snapshot of the atom to the observation-label. Therefore, the S-G experiment refutes the single-qubit carrier-symbol snapshot traceability assumed by the Feynman-Deutsch theory.

Although the S-G experiment is an eigenvalue measurement experiment for the ensemble of two-state quantum objects, it involves the collapse-conversion process of individual qubits. Based on the S-G experiment, it can be deduced that for a single isolated two-state atom, there is no traceability from the collapsed eigenstate symbol snapshot to the observation label, and there is no traceability from the eigenvalue-carrier to the observation label carrier.

Therefore, our conclusions are as follows. (1) The S-G experiment proves the existence of the single-particle collapse information. (2) The S-G experiment proves that the collapse information of the atomic ensemble is transmitted as statistical information to the observation-space coordinate system; and that the statistical information of the atom-ensemble collapse is high-fidelity information. (3) By the S-G experiment, the dual traceability of both single eigenvalue-snapshot and single eigenvalue-carrier-snapshot is falsified, and the Feynman-Deutsch's $|\psi|^2$(qubit) reading hypothesis is falsified.

5.3 The single-qubit carrier-symbol snapshot traceability introduces intrinsic correlation between CS_M and CS_C in the depth direction. Schrödinger superdepth map involves the chip engineer's contraction mapping experiments.

For the single-qubit reading, the fundamental assumption of quantum computing is the double probability density, which specifies the correspondence between two coordinate systems CS_M and CS_C in the depth direction. The Feynman-Deutsch theory selects the double probability density with the single-qubit carrier-symbol snapshot traceability and excludes the double probability density without the single-qubit carrier-symbol snapshot traceability. Thus, in order to ensure the realization of the double probability density with the single-qubit carrier-symbol snapshot traceability, people have to assume that there is an intrinsic link in the depth direction between CS_M and CS_C, that is, there is a fixed point, which is related to the spatial location of the carrier wearing outcome 0 (or 1) and the spatial location of the carrier wearing eigenvalue symbol ↑ (or ↓). On the other hand, Born Rule and the related measurement postulates do not assert whether there is an intrinsic link in the depth direction between CS_M and CS_C. Now we relate the single-qubit carrier-symbol snapshot traceability to a well-known geometric problem: the contraction mapping between coordinate systems CS_M and CS_C. The physical space described by the observation-space coordinate system is mathematically a complete metric space. The Banach contraction mapping theorem is an important tool in the theory of metric spaces and only important principle in mathematics that provides the depth relationship between two coordinate systems. According to the Banach contraction mapping theorem, for the contraction mapping from a complete metric space to itself, there is a unique fixed point. The fixed point can be shown by making the map a contraction. Schrödinger [17] assumed in his cat thought experiment that there is an intrinsic link between an eigenstate-label-carrier and an observation-label-carrier (cat). Namely, in the sense of Schrödinger's experiment, the eigenstate-to-observation conversion operation is analogous to the operation of zooming in and out on a conceptual superdepth map (or a "super Google Map"). Thus, we refer to Schrödinger's eigenstate-to-observation information conversion, which describes the traceability relation between CS_M and CS_C, as Schrödinger superdepth map.

We consider the following map series (Fig. 3d): Map-6 (micro-observer's map or coordinate system in which an electron is taken as a coordinate carrier), Map-5 and Map-4 (chip engineer's map or coordinate system in which a nano-scale object is taken as a coordinate carrier), Map-3 (human map or coordinate system in which a daily visible object is taken as a coordinate carrier), Map-2 (a map such that a planet is taken as a coordinate carrier), Map-1 (a map such that a part of a galaxy is taken as a coordinate carrier). In the contraction mapping from galaxy Map-1 to human Map-3, there is clearly a fixed point (such as the origin of the coordinate system established by the human observer), and the Banach contraction mapping theorem holds experimentally. Assuming Map-4 and Map-5 are two maps with coordinate carriers of 40 nm size and 10 nm size, respectively, the chip engineer use the projection optical system to project the image of the specified pattern, at the prescribed reduction ratio 1/4, onto the wafer. Obviously, the Banach compression mapping theorem is one of the theoretical foundations of projection optical systems. For Map-1, Map-2, Map-3 and Map-4, the Banach contraction mapping theorem holds experimentally. As shown in Fig. 3d, an observer can effectively click on the "+" key of this figurative depth map to enlarge the Map-1 into the Map-2 in which a planet is taken as a coordinate carrier. The observer can click on the "+" button again to further enlarge the map into the Map-3 in which there is a box that contains a poison-releasing device and Schrödinger's cat. The observer clicks the "+" button to further enlarge the map into the micro-observer's Map-6 in which there is a silver atom whose spin state determines whether the device inside the box in Map-3 releases the poison or not. Finally, the observer clicks on the "-" button to return Map-3. The Schrödinger superdepth map assumes that the inverse element of the cat in Map-6 is traceable. This means that there is a fixed point common to Map-3 and Map-6. That is, when the observer clicks on the "+" button in Map-3, the observer can trace back to the inverse element of the cat in Map-6, that is, the carrier of the eigenvalue snapshot. We show in the next sections that the theoretical basis of the Schrödinger thought experiment – the Schrödinger superdepth map – is not supported by the chip engineer's contraction mapping experiments.

5.4 Experimental falsification of single-qubit reading capability (2): The chip engineer's contraction mapping experiments is a falsification experiment for the dual traceability of both single eigenvalue-snapshot and single eigenvalue-carrier-snapshot.

(1) According to the principles of quantum mechanics, the coordinate carrier (atom) within the state-space coordinate system CS_M cannot be accurately located, and the distance between the two coordinate carriers cannot be accurately measured. Therefore, from a theoretical point of view, there is no fixed point between the micro-observer's Map-6 and the chip engineer's Map 5. (2) From an experimental point of view, we examine chip engineer's contraction mapping experiment. The operation of the wafer processing lithography machine equipped with the projection optical system is actually contraction mapping experiment in nano scale. The diameter of the atom is about 0.1 nm. So far, the lower limit of the chip engineer's contraction mapping experiment is not less than 1 nm. This lower limit means that the chip engineer's experiments do not support the contraction mapping from human coordinate system CS_C (Map-3) to the state-space coordinate system CS_M (Map-6). The chip engineer's contraction mapping experiments implies that there is no intrinsic geometric connection between CS_M and CS_C, that is, no intrinsic geometric connection between a spatial location within CS_M and a spatial location within CS_C. Therefore, the chip engineer's experiments falsify the assumption that there is a fixed point between the spatial location of the observation-label-carrier wearing outcome "0" (or "1") and the spatial location of the carrier-cell wearing state-symbol $|0\rangle$ (or $|1\rangle$). Namely, the chip engineer's experiments falsify the single-qubit carrier-symbol snapshot traceability, falsify the double probability density and the Feynman-Deutsch's $|\psi|^2$(qubit) reading hypothesis. The geometric relevance between CS_M and CS_C is a more profound problem, which we will discuss in section 10.

5.5 It is shown that quantum computing is incompatible with Born Rule and the related measurement postulates. The root of everything wrong with quantum computing is the double probability density hypothesis.

The core of Born Rule is to specify the relation between measurement and $|\psi|^2$ based on de Broglie's matter waves. The key to prove the incompatibility of quantum computing with Born Rule and the related measurement postulates is the demarcation criterion between Born Rule and the Feynman-Deutsch's qubit reading hypothesis: the double probability density hypothesis hidden in the technical scheme. In the hundred years since the establishment of quantum mechanics, no authoritative works have imagined that the matter waves for single-particle within CS_M, as waves of probability, can map to the observation-space coordinate system CS_C in terms of measurements. The double probability density hypothesis imagines that the observers can map the probability cloud of single-qubit within CS_M to CS_C in a global way in terms of measurements, and establish a deterministic correlation between the microscopic and macroscopic coordinate systems. This mapping is completely incompatible with the fundamental idea of quantum mechanics. The root of everything wrong with quantum computing is the double probability density ($|\psi|^2$ mapping) hypothesis. In Sections 4 and 5, we show that the double probability density hypothesis necessarily requires the single-qubit carrier-symbol snapshot traceability. We prove that quantum computing is incompatible with Born Rule and the related measurement postulates. We falsify the Feynman-Deutsch's $|\psi|^2$(qubit) reading hypothesis, which tries to bypass Born Rule. Our proof negates the feasibility of the single-qubit reading.

6 Time Evolution Postulate Is Not Applicable To Quantum Computing. Custom-built Time Evolution Rule Is Hidden In The Technical Schemes. A Proof Of The Compatibility Of Quantum Computing With The Original Time Evolution Postulate Has Never Been Provided In

6.1 The time evolution theory for quantum computing is non-transparent.

We investigate the incompatibility of quantum computing with Time Evolution Postulate. The time evolution described by unitary transformation sequence must obey Time Evolution Postulate. C. Cohen Tannoudji et al. (or y. Peleg et al.) expressed the time evolution postulate VI as follows: The time evolution of the state vector $\Psi(\mathrm{t})$ of a physical system is governed by the Schrödinger equation: $\mathrm{i}\hbar\partial\psi/\partial t=\mathrm{H}(\mathrm{t})\,\psi$, where H(t) is the observable associated with the total energy of the system. The time evolution theory for quantum computing is non-transparent, because the main authors of quantum computing have not provided definitive answers to the following three fundamental questions. (1) For N-qubit quantum computing, "the time evolution of the state vector of a physical system" is specified by the N-qubit u-transformation sequence. Can the single-qubit entry-to-exit traversal be separated from the u-transformation sequence for N qubits? (2) Postulate VI specifies H(t) as an observable associated with the total energy, without any assertion about non-observable. Whether the introduction of non-observable in the Feynman-Deutsch theory in the time evolution of the state vector implies a modification of Time Evolution Postulate? (3) Whether the transformations and couplings involved in the time evolution specified by the Feynman-Deutsch theory require customization of other quantum mechanical principles.

6.2 The existence of the entry-to-exit traversal of single-qubit has been hidden in the technical schemes.

Deutsch, Bernstein & Vazirani, Shor, DiVincenzo et al. in their theoretical schemes sometimes discuss the transformation acting on one bit and sometimes discuss the transformation acting on N bits. For example, Deutsch wrote: “All programs for Q can be expressed in terms of the ordinary Turing operations and just eight further (quantum) operations. These are unitary transformations confined to a single two-dimensional Hilbert space H, the state space of a single bit.” “The dynamics of Q are summarized by a constant unitary operator U on H (here, H is a Hilbert space spanned by the eigenvectors $|x; n; m\rangle$ involving L qubits).” DiVincenzo’s expression is different from Deutsch’s, he does not insist that the unitary transformation acts on N bits. He wrote: a quantum algorithm is specified as a sequence of unitary transformations, and each transformation acts on one or two or three bits. The main authors of the Feynman-Deutsch theory apparently avoid the question whether a u-transformation sequence for one qubit (i.e., a single-qubit entry-to-exit traversal) can be separated from the u-transformation sequence for N qubits. Research on single-qubit reading has shown that the theoretical scheme of quantum computing is not a complete logical system, and that the principal statement may be hidden in the technical scheme. In fact, the existence of the entry-to-exit traversal of single-qubit has been hidden in the technical schemes, and has been implied in the quantum circuit of practical quantum computers. For example, in the three experiments (Shor factoring) A, B, and C, clearly, the single-qubit entry-to-exit traversals can be separated from quantum circuit (see Fig. 1a). Therefore, although the main authors of the Feynman-Deutsch theory are not sure about the existence of single-qubit entry-to-exit traversal, in the practical quantum computers it has been actually accepted the principle hidden in technical schemes and quantum circuits: the single-qubit entry-to-exit traversal can be separated from the u-transformation sequence of N-qubit. In fact, the existence of a single-qubit entry-to-exit traversal is a logical consequence of the Feynman-Deutsch theory. (1) The main authors of the Feynman-Deutsch theory accepted the concept of tape position movement in their papers. The concept of tape position inevitably leads to the separability of single-qubit entry-to-exit traversal. (2) The fact that the DiVincenzo criteria specify the initialization of single-qubit and the single-qubit reading already implies the existence of a single-qubit entry-to-exit traversal linking a single-qubit entry with a single-qubit exit. The significance of this auxiliary hypothesis should never be underestimated. When people understand quantum algorithms as a sequence of unitary transformations on the Hilbert space for N bits, they will think that anti-determinism principles have no power to supervise their hypotheses. Once the quantum algorithm is reduced to a single-bit entry-to-exit traversal, the designer of the theory must explain whether the single qubit track implies deterministic behavior.

6.3 The first step for the transparency: the single-qubit entry-to-exit traversal is specified by behavior track and carrier-cell track.

The single-bit entry-to-exit traversal can be described in terms of a timeline and its tracks. The situation is similar to that a timeline has a video track and an audio track when editing video. As shown in Fig. 4a, the timeline has one behavior track (symbol track) and one carrier-cell track. The behavior track and the carrier-cell track give the exact form of the single-qubit entry-to-exit traversal as follows. (a) The entire timeline is divided into three types of time intervals: symbol gaps Γ_i, action segments Δ_i and collapse glimpse. Here we only consider the symbol gaps and the action intervals before the end of the computation. Figure 4a shows the key time points on the timeline: $t_{1,1}$, $t_{1,2}$, $t_{2,1}$, $t_{2,2}$, ... The two key time points for the specific action segment Δ_i are: incoming time $t_{i,1}$ and outgoing time $t_{i,2}$. The two key time points for the specific symbol gapΓ_i are: outgoing time $t_{i,2}$ and incoming time $t_{i+1,1}$. (b) For a time point t, there are two pieces of information: single-qubit cell information and single-bit behavior information. We can use the term "snapshot (or frame)" to express the information. For example, at the time point $t_{2,2}$, the snapshot on the behavior track is state \left| \downarrow \right\rangle. (c) Obviously, for a single-bit entry-to-exit traversal, the single carrier-cell is unique, so that the image of the carrier-cell track is a straight line, and the snapshot is the same for all key time points.

We have achieved the first step for the transparency: We show that the quantum algorithm given by the Feynman-Deutsch theory is reduced to the existence of the single-qubit entry-to-exit traversal, that the single-qubit entry-to-exit traversal is specified by two tracks: the single-qubit behavior track and the carrier-cell track, and that there are three types of time intervals on the track: symbolic gaps, action segments, and collapse glimpse. The second step for the transparency will be to expose the additional choices people make for the single-qubit behavior track, including changing the structure of the u-transformation sequence and adding assertions about non-observable.

6.4 The single-qubit stepwise time evolution hypothesis is hidden in the technical scheme of the unitary transformation sequence.

For the time evolution on single-qubit behavior track (including gaps and actions), the Feynman-Deutsch theory has not provided a theoretical scheme. Only DiVincenzo provided the following technical scheme in his criteria: “to identify Hamiltonians which generate these unitary transformations… then, the physical apparatus should be designed so that H_1 can be turned on from time 0 to time t, then turned off and H_2 turned on from time t to time 2t, etc.…The overall time scale of the interaction pulse is also controlled by the attainable maximum size of the matrix elements of H (t), which will be determined by various fundamental considerations… the ‘clock time’ of the quantum computer will be determined by the time interval needed such that two consecutive pulses have negligible overlap.”

On the surface, DiVincenzo's technical scheme has no clause for zero distance from the postulates of quantum mechanics, but this is not the case in practice. A single-qubit stepwise time evolution hypothesis is hidden in the technical scheme of the u-transformation sequence, which includes two clauses with zero distance from the quantum mechanical postulates: the DiVincenzo zero-life-gap hypothesis (i.e., the DiVincenzo negligible overlap hypothesis, see Section 1.3) and single-qubit time evolution with no observables. There are two possible choices for the gap between two transformations in practical quantum circuit diagrams: zero-life-gaps and non-zero-life-gap. Classical algorithms are implemented in modern computers by means of integrated circuits. In an integrated circuit, all discrete components are put on a chip and connected with copper lines, in which there are non-zero-life coupling symbols between the two components. The non-zero-life connection between the two components has been experimentally verified. For quantum circuits, the situation is completely different. DiVincenzo's zero-life-gap hypothesis implies that one makes principal modification to the single-qubit behavior track. Figure 4.b shows the modified single-qubit behavior track, where the symbol gaps are turned into mathematical points, and the single-qubit behavior track consists of action segments only. The zero-life-gap is unobservable, and the single unitary transformation itself is also unobservable. Thus, there are no observables for the entire single-qubit behavior track, which consists of zero-life-gaps and unitary transformations. From the standpoint of falsifiability, according to Deutsch's testability statement, "Q must not be observed before the computation has ended", there can be no observables on the single-qubit behavior track. Now, transparency enables us to express the single-qubit time evolution hypothesis hidden in the technical scheme in an explicit form as follows: For a single-qubit entry-to-exit traversal, the “single-qubit stepwise time evolution” specified by the unitary transformation sequence satisfies the following three conditions. (1) The single-qubit time evolution occurs before the end of the calculation, and has been under the condition of no observation. (2) This time evolution contains a sequence of zero-life symbol gaps, which is a predictable stepwise sequence. (3) No observation means that the Hamiltonian that specifies the time evolution is non-observable. Note that in this paper, the term "single-qubit stepwise time evolution" usually means that this time evolution is in the absence of observation and without non-zero-life symbol gap.

6.5 Time Evolution Postulate is not applicable to quantum computing. Custom-built Time Evolution Rule - an altered Time Evolution Postulate is introduced in the Feynman-Deutsch theory.

The question of whether Time Evolution Postulate is applicable to quantum computing now becomes a question of whether the single-qubit stepwise time evolution is applicable to quantum computing. There are the following conflicts between Time Evolution Postulate and the time evolution required by the Feynman-Deutsch theory. (a) Time Evolution Postulate asserts that H(t) is defined as observable, and the measurement results of H(t) are governed by the measurement postulates. Time Evolution Postulate does not assert the time evolution of the system in the absence of observation. The Feynman-Deutsch theory requires time evolution in the absence of observation, and the Hamiltonian that cannot be observable. This is the conflict between time evolution in the presence of observation and time evolution in the absence of observation. (b) Time Evolution Postulate asserts the probability distribution of particles with specific energy eigenvalue labels in physical space. The physical quantity represented by operator H(t) is measured a large number of times when the system is in the specific state. The Schrödinger equation does not assert time evolution of single bit trapped in a fixed tiny volume. The Feynman-Deutsch theory requires time evolution of single bit trapped in a fixed tiny volume. (c) Time Evolution Postulate asserts that the possible results (probability distributions) of an observable H(t) at a specified time, and does not assert the situations where the control bit has a predictable eigenstate. Time Evolution Postulate does not assert the predictability of zero-life symbol gap sequence. The Feynman-Deutsch theory requires the predictability of zero-life symbol gap sequence.

Therefore, we conclude that Time Evolution Postulate is not applicable to the single-qubit stepwise time evolution, that is, it is not applicable to quantum computing. The original Time Evolution Postulate does not involve the time evolution in the absence of observation and does not involve the description of the single-qubit behavior track. The existence of the single-qubit entry-to-exit traversal and the exact form of the single-qubit behavior track are refutations of the compatibility of the Feynman-Deutsch theory with Time Evolution Postulate.

We have already pointed out in Section 1.2 that the key to a proper understanding of the methodology of quantum computing is to expose the strategic hiding mechanism implicit in quantum computing theory: to make new assertions about things that the postulates of quantum mechanics cannot assert, and to hide the new assertions in the technical schemes. We call the new assertion involving "time evolution in the absence of observation", which tampers with Time Evolution Postulate, Custom-built Time Evolution Rule, because it is a custom-built rule for quantum computing of N-qubit. Custom-built Time Evolution Rule is not a special case of the original Time Evolution Postulate.

Custom-built Time Evolution Rule. (1) If the quantum system is a system of micro-particles (electrons, atoms, or other particles) rather than an N-bit system as described by quantum computing, then the form of Time Evolution Postulate is as described in mainstream quantum mechanics textbooks. (2) If the quantum system is an N-bit system described by quantum computing, then Custom-built Time Evolution Rule includes the following new assertions. (a) Time evolution is realized in the absence of observation; the corresponding Hamiltonian is a non-observable before the end of quantum computation. (b) The carrier-cell of single-qubit is always trapped in a tiny volume within macro-space before the end of the computation. (c) For a single-qubit entry-to-exit traversal, there is always a stepwise time-evolution Hamiltonian describing a zero-life-gap sequence for single-qubit. (d) The eigenstate of the control qubit is allowed to be predictable.

6.6 The Feynman-Deutsch theory has never provided a proof of the compatibility of quantum computing with the original Time Evolution Postulate.

Deutsch stated in his paper: "I shall now sketch a proof of the existence of a program that effects a unitary transformation on L bits, arbitrarily close to any desired unitary transformation." Deutsch's proof of the existence of the desired unitary transformation for N-bit is such a proof that is away from practical quantum computers and sidestep the core issues of zero distance from the original Time Evolution Postulate. (1) In practical quantum computers, the transformation sequence of N bits from entry to exit can be reduced to single-qubit entry-to-exit traversals. Under the condition of no observation, the unitary transformation sequence acting on single-quit is a sequence of non-observables. Deutsch's mathematical proof does not provide the basis of quantum mechanical postulates for the sequence of non-observables. (2) In the technical schemes of quantum computing, for single-qubit entry-to-exit traversal, the existence of zero-life symbol gaps and a predictable sequence of zero-life couple-symbol gaps (including zero-life eigenvalue gap) are assumed. Deutsch's proof does not provide a basis of quantum mechanical postulates for the existence of this predictable sequence of zero-life couple-symbol gaps. The Feynman-

Deutsch theory only provides a mathematical basis for individual unitary transformations (individual logic gates), completely ignoring the basis of quantum mechanical postulates for the realization of the coupling between two unitary transformations. For two unitary transformations U_1 and U_2 (assuming that the output of U_1 is equal to the input of U_2), it is not enough to experimentally prove that U_1 and U_2 are valid separately; a proof of the validity of the zero-life connection between the two transformations must be provided. The existing quantum mechanical theory does not provide the theoretical basis of the corresponding quantum techniques. Although Deutsch showed that for each L-bit state \psi there exists a Q-program which accurately evolves \psi to the desired state, his proof lacking sequence of zero-life couple-symbol gaps is clearly far from sufficient. (3) In the technical scheme of quantum computing, single-qubit stepwise Hamiltonian is assumed for single-qubit entry-to-exit traversal. Deutsch's proof does not provide the exact form of this single-qubit stepwise Hamiltonian and the corresponding basis of quantum mechanical postulates. (4) Let us consider the case: a bit in an action segment is designed as a control bit, and the incoming state symbol is a specific single eigenstate. An example is the action segment s_3 in quantum computing experiment A (Shor factoring) (see Fig. 1), which is one of the action segments in the single-qubit stepwise time evolution. On the one hand, the eigenstate of the control bit undergoing the interaction of two qubits can be predicted. On the other hand, Time Evolution Postulate does not describe the trapped single particle, and also does not assert the predictability of time evolution results. Thus, for this action segment, there is a conflict between the predictability of single-qubit behavior and the anti-determinism principle. The existing theory of quantum mechanics does not provide the theoretical basis of the corresponding quantum technology.

Therefore, the Feynman-Deutsch theory, which ignores the non-observable character of time evolution and the zero-life coupling-symbol gap, has never provided a proof of the compatibility of quantum computation with Time Evolution Postulate. The view that the Feynman-Deutsch theory has proved the compatibility of quantum computation with Time Evolution Postulate is completely wrong.

6.7 Remarks.

(1) We have not introduced any new theory; we have only revealed the postulate-level assumption–Custom-built Time Evolution Rule hidden in the technical schemes of the Feynman-Deutsch theory in an explicit form. Custom-built Time Evolution Rule is actually an anti-traditional principle describing the time evolution of single particle. (2) We show that the Feynman-Deutsch theory never provides a proof of the compatibility of quantum computing with Time Evolution Postulate. We do not falsify Custom-built Time Evolution Rule, because the unitary transformation sequence belongs to the unfalsifiable part and is protected by the Achilles mechanism; it is impossible for the falsifier to produce experimental evidence unfavorable to the unitary transformation sequence. (3) The single-qubit stepwise time evolution required by quantum computing is non-observable behavior that occurs in the unfalsifiable part. It is important to note that the description of non-observable occurrences has been a source of disagreement in the field of quantum physics. Heisenberg pointed out that "The demand of 'describe what happens' in the quantum-theoretical process between two successive observations is a contradiction in adjecto…" Feynman pointed out an idea people have: we should not speak about those things which we cannot measure.

Therefore, Custom-built Time Evolution Rule involves academic disagreement. Until the academic disagreement is resolved, "the single-bit stepwise time evolution in the absence of observation" should be considered as a thought experiment. Of course, the predictable behavior between two observations, as in the case of hidden parameter theory, remains a legitimate academic view.

7 The Falsifiability Criteria Of Quantum Computing Implementation And The Mistake Of The Divincenzo's Criteria, Claimed Implementations Of The Shor Quantum-factoring Algorithm Are Invalid.

7.1 Classification of criteria for the implementation of quantum computing: falsifiability criterion, traversal criterion and fragment criterion. The deficiencies of the DiVincenzo criteria.

"Q must not be observed before the computation has ended (Deutsch)" is the highest criterion for quantum computing. We must distinguish falsifiability criterion, which involves the qubit reading only. We refer to the criteria on the unitary transformation sequence as second-level criteria, none of which are falsifiability criteria. We divide the second-level criteria into traversal criteria and fragment criteria. The traversal criterion relies on the globality characteristics of single-qubit soloing track. The fragment criterion only involves the local characteristics of the traversal. We put the falsifiability criterion in the first place in the physical implementation of quantum computing.

Falsifiability criterion: For quantum computing, there are only one falsifiability criteria: the double probability density (including the single-qubit carrier-symbol snapshot traceability). (1) If the double probability density is falsified, the single-qubit reading fails, and the quantum computing fails. (2) If the double probability density is not falsified, the achievability of any item before the end of the calculation is indirectly tested by means of probability reading based on the double probability density.

All of the DiVincenzo's criteria except the fifth criterion (qubit specific measurement capacity) are not falsifiability criteria. The ability of initializing the states of qubits, the ability of increasing the number of qubits and the ability of universal set of quantum gates are fragment criteria.

There are three traversal criteria, which are directly derived from quantum mechanics principles and the qubit definition.

Single-qubit identity criterion

For a single-qubit entry-to-exit traversal in quantum computing, the qubit bearing the state symbol must satisfy the requirement of single-qubit identity, that is, the qubit on the bit track must be the same at any time point. If a quantum computation cannot provide a theoretical proof and an experimental proof of the single-qubit identity, then this quantum computation is considered to use speculation and is ruled as a failure.

Coupling-symbol uniqueness criterion: For a single-qubit entry-to-exit traversal in quantum computing, suppose that the symbol gap (i.e., symbol-section) between two successive actions on the behavior track is $\Delta = (t_1,t_2)$. The state-symbols bore by the qubit within Δ must satisfy the requirement of coupling symbol uniqueness: either $S(t_2) = S(t_1)$ ($S(t_1)$ is the outgoing symbol, $S(t_2)$ is the subsequent incoming symbol), or Δ is zero life. If the symbol gap Δ is a zero-life gap, and the existence of the coupling symbol $S(t) = S(t_2) = S(t_1)$ is undecidable, then this quantum computing is judged as a failure.

Anti-determinism criterion

For a single-bit entry-to-exit traversal in quantum computing, If there exists a time interval Δ such that the eigenstate-symbol bore by the single bit is predictable, then we say that this single bit has deterministic behavior on Δ. This quantum computation is judged as a failure.

The judgment of the implementation of quantum computing ultimately relies on falsifiability criterion. The DiVincenzo criteria ignore the fact that only the single-qubit reading is the falsifiability criterion, which determine the life and death of quantum computing. For the second-level criteria, the DiVincenzo criteria focus on the fragment criteria and decoherence, and does not focus on the verifiable primary matters: deterministic behavior, coupling symbol uniqueness, single-qubit identity. The DiVincenzo criteria artificially magnify the value of qubit scalability, universal set of quantum gates, and decoherence, artificially magnify the value of the realization of a single unitary transformation. The DiVincenzo criteria keep the researcher's attention away from the center of quantum computing, i.e., qubit reading (the double probability density). This is a major deficiency of the DiVincenzo criteria.

7.2 The crucial experiment for the realizability of quantum computing is the single-qubit Postulate IV experiment (double probability density experiment).

The demarcation criterion between Born Rule and the Feynman-Deutsch's qubit reading rule is the double probability density. We present a crucial experiment on the realizability of quantum computing, the single-qubit Postulate IV experiment (double probability density experiment). It tests that the probabilities P(0)= {\left| {\left\langle 0 \right|\left. {{\psi _{{\text{bit}}}}} \right\rangle } \right|^2} and P(1)={\left| {\left\langle 1 \right|\left. {{\psi _{{\text{bit}}}}} \right\rangle } \right|^2} within CS_M required by Postulate IV map to the observation-space coordinate system CS_C, where the probability mechanism is the zeroing and reuse of single-qubit. The design of the crucial experiment is shown in Fig. 5a, and the output probability distributions for the three qubits are: in ideal measurements, the probability distribution (1/4, 3/4) for the first qubit (the wavefunction {\raise0.7ex\hbox{1} \!\mathord{\left/ {\vphantom {1 2}}\right.\kern-0pt}\!\lower0.7ex\hbox{2}}\left| 0 \right\rangle +{\raise0.7ex\hbox{${\sqrt 3 }$} \!\mathord{\left/ {\vphantom {{\sqrt 3 } 2}}\right.\kern-0pt}\!\lower0.7ex\hbox{2}}\left| 1 \right\rangle), probability 1 for the second qubit (the density \left| 0 \right\rangle \left\langle 0 \right|), and the probability 1 for the third qubit (the density \left| 1 \right\rangle \left\langle 1 \right|).

Until this crucial experiment is successful, other known quantum computing test experiments, including the experiment of quantum supremacy, are meaningless.

7.3 Three Shor quantum-factoring experiments A, B and C are considered, in principle, to be valid in the sense of the DiVincenzo criteria.

Let us examine whether the three Shor quantum-factoring experiments A, B and C satisfy the DiVincenzo criteria. (1) The first DiVincenzo criteria are well-characterized qubits and a scalable physical qubit-system. Experiments A, B and C clearly satisfy the condition of well-characterized qubits. In terms of scalability, paper A argued: "This method of using nuclei to store quantum information is in principle scalable to systems containing many quantum bits, but such scalability is not implied by the present work…However, they can in principle be improved…" Experiments A, B, and C can thus be considered to satisfy scalability in principle. (2) The second DiVincenzo criterion is the ability to initialize the state of the qubits to a simple fiducial state. Paper A wrote: "The desired initial state of the seven qubits is $\left|{0000001} \right\rangle$". The three experiments satisfy the second criterion. (3) Experiments A, B and C satisfy, in principle, the fourth DiVincenzo criterion of a universal set of quantum gates. (4) The third DiVincenzo criterion is long relevant decoherence times. The fifth DiVincenzo criterion is that the result of a computation must be read out, which requires the ability to measure specific qubits. Since these experiments have complete measurements and the results have been read, all three satisfy criteria 3 and 5. Therefore, these three quantum computing experiments satisfy the DiVincenzo criteria, in principle, and are thus valid in the sense of the DiVincenzo criteria.

7.4 Quantum computing experiment A does not satisfy the anti-determinism criterion. No evidence for double $\left| \psi \right|^2$ is provided.

In quantum computing experiment A, the sequence of unitary transformations U_1, U_2, U_3,… are realized by means of the pulse sequence. The sequential time-evolutions of a single bit means that the machine carries out successively pulses P_1, P_2, P_3, .., that is, as DiVinsenzo said: from time $t_0$to time t_1, pulse P_1 is turned on, then turned off, and then from time t_1 to time t_2 Turn on pulse P_2, etc. The pulse is used to implement a single unitary transformation. Experiment A actually used DiVinsenzo's "negligible overlap" hypothesis, by which, two consecutive pulses have negligible overlap, that is, the symbol gap between the two pulses has a zero lifetime. Thus, s_3 becomes an action segment such that the incoming symbol is a single-eigenstate symbol, and the qubit in the single-eigenstate is used as a control qubit. The action segment s_3 must be specified by a definite time interval ($t_1 \le t \le t_2$) rather than by idealized infinitesimal time interval. Therefore, experiment A actually assumes that there is always the effect of pulse and control qubit in the time interval ($t_1 \le t \le t_2$), and the state-symbol of control bit is predictable. Experiment A did not provide off-site experimental evidence and theoretical evidence that the pulse can make the state-symbol of the control qubit predictable. In this way, experiment A violates the anti-determinism criterion.

In experiment A the double {\left| \psi \right|^2} hypothesis directly is used, but no evidence for double {\left| \psi \right|^2} is provided.

7.5 Quantum computing experiments B and C do not satisfy the single-bit identity criterion, do not satisfy the coupling-symbol uniqueness criterion.

The underlying idea of quantum computing is that the state-symbol is bore by qubit. In the works of the authors of Feynman Deutsch theory, the term "symbol" is defined as the symbol worn by a single qubit, not the symbol worn by a qubit-beam. For quantum algorithm experiment using qubit-beam, the single-qubit identity criterion must be used to judge the legitimacy of the quantum algorithm.

Quantum computing experiments B and C both neglect the single-qubit identity authentication. The basic building block of optical quantum computing is a single trapped two-state photon. Single-qubit identity authentication requires showing that photon P_1 in the input state, photon P_2 during the transformation process, and photon P_3 being read are the same photon (as shown in Fig. 5b). Optical quantum computing is an experimental science; there is no reason to neglect single-bit identity authentication. However, Quantum computing experiments B and C do not present any single-bit identity authentication experiments in their reports and no literature on such an identity authentication experiment is cited in the references.

The Haroche experiment [18] describes the momentary trapping of single photons by means of red and blue bars (observation-label carriers) in the QND detection system. The wave-particle duality of light is a physical consensus, and the Haroche experiment shows the difficulty of trapping a long-lifetime single photon. In experiments B and C, the single photon recognized in the detector is considered to be identical to the single photon of the input state. However, these two experiments use a photon beam in some stages but a single-photon process in the final stages. Thus, experiments B and C neglect the single-bit identity authentication. The existing optical theory demonstrates that a photon beam can continuously have eigenvalues described by classical concepts (such as horizontal or vertical polarization); hence, we appear to be able to trap the eigenstate of a photon beam. However, no experiment has provided evidence that a single eigenstate of a single photon can be trapped. Notably, the spatial characteristics of photons include self-interference or non-self-interference (for instance, the self-interference of photons in the double-slit experiment). For a single photon with a specific observation label (e.g., red and blue bars), it is impossible to prove that the photons P_1, P_2 and P_3 are the same photon. We examine the infeasibility of the following identity authentication experiments. (a) For pulses originating from a source one by one, as shown in the upper part of Fig. 5c, quantum mechanics does not require that the photons in the first pulse can be translated into the second pulse in the sense of classical physics; it is impossible to identify the photons contained in a pulse as a wave packet and their spatial form of existence. Thus, a photon may move in a retrocausal sense. Therefore, exchange of photons P and Q is possible. Furthermore, it is impossible to prove that a photon M reaching the target is the same as a photon N starting at the source. (b) As shown in the lower part of Fig. 5c, a photon beam split by a polarizing beam splitter (PBS) could be trapped in the eigenstate in a statistical sense only: the photons P and Q may be in the states \left| V

\right\rangle and \left| H \right\rangle, respectively, at time t_1 and in the states \left| H \right\rangle and \left| V \right\rangle, respectively, at time t_2. Therefore, in optical quantum computing, the identity authentication experiment for a single photon is infeasible, which confirms the homogeneity of individual bits from entry to exit.

Unlike experiment A, in quantum calculations B and C, there is a non-zero-life time gap for the photon beam between the two optical devices. The coupling-symbol uniqueness criterion requires evidence that the outgoing photon is the subsequent incoming photon at the instant of turning on the second action, and their symbols are the same. In the quantum experiments B and C, the experimenter can only confirm that the incoming photon beam at the instant of turning on the second action is exactly that outgoing photon beam. Since quantum computing experiments B and C do not satisfy the single-bit identity criterion, and the homogeneity of individual bit from entry to exit is improvable. On the other hand, one cannot exclude the possibility that the self-interference of photons makes the eigenstate of individual photon undecidable. Therefore, quantum computing experiments B and C do not satisfy the coupling-symbol uniqueness criterion.

7.6 Quantum computing (Shor factoring) experiments A, B and C are invalid.

Our conclusions are as follows. (1) The falsifiability criterion, i.e., the double probability density criterion, is the criterion of highest authority, and experiments A, B, and C provide no evidence of double probability density for single-qubit. (2) Quantum computation A does not satisfy the anti-determinism criterion, and it is judged as a failure. Quantum computing experiments B and C do not satisfy the single-bit identity criterion and the coupling-symbol uniqueness criterion, and they are judged as failures. (3) Optical quantum computing experiments B and C are actually quantum computing experiments of photon beams. They cannot be regarded as quantum computing described by the Feynman-Deutsch theory. For quantum computing experiments B and C, control experiments should be provided. The control experiments should be similar to the experiment B and C, but with a beam instead of a single photon. (4) Experiments A, B and C show that their output (computation result) is consistent with the predictions derived by the algorithm. However, this consistency is not evidence of quantum computing because the anti-determinism criterion, the single-bit identity criterion and the coupling-symbol uniqueness criterion are the life-or-death criteria, which have the power of one vote veto.

These conclusions also apply to ionic quantum computing experiments (Shor factoring) and all optical quantum computing experiments (Shor factoring). Thus, 20 years of Shor factoring quantum computing have led to no progress. For quantum computing, the crux of the problem is not whether the process is fast or slow but whether it is possible or impossible.

8 Conclusion

8.1 The Feynman-Deutsch theory provides a wrong tree structure of quantum computing. The Feynman-Deutsch theory is a theory with low degree of strictness and with the lowest testability in physics.

The Feynman-Deutsch theory provides a wrong tree structure of quantum computing (see Fig. 2). Two errors in the tree structure of quantum computing are as follows. (1) The basic components of quantum computing are algorithm (sequences of logic gates) and qubit reading (extracting the algorithm's output). The quantum mechanical principle governing qubit reading should have been Born Role. However, Born Rule (including the relevant eigenvalue measurement postulates) is removed from the root of the tree structure of quantum computing and replaced by the double $\left| \psi \right|^2$ hypothesis. The testability of the algorithm and the testability of qubit reading are not publicized. To be exact, the fact that whether the testability of the algorithm ultimately depends on qubit reading has not been publicized. In this way, the tree structure of quantum computing is non-transparent. In fact, all domains of quantum physics except quantum computing are transparent because for the tree structure of these domains, all root nodes and the paths from the root to the child nodes are visible. Quantum computing is the only branch of quantum mechanics with zero distance from quantum measurement postulates since the establishment of quantum mechanics. The wrong tree structure for quantum computing means that the logical system of quantum computing is abnormal and incomplete. The theoretical system described by the main authors of the Feynman-Deutsch theory is not the whole of the quantum computing theory, the assumptions involving Born Rule (including the eigenvalue measurement postulates) are hidden in the technical scheme.

The Feynman-Deutsch theory is a theory with low degree of strictness and low degree of falsifiability. (1) The double $\left| \psi \right|^2$ hypothesis (including the single-qubit carrier-symbol snapshot traceability) is used to replace Born Rule and is implemented in the name of quantum technology, but is hidden in technical scheme and does not appear in the formal theory. (2) A basic principle of quantum computing is Deutsch's testability statement that quantum computing must not be observed before the computation has ended. Therefore, quantum computing must be divided into two parts: the unfalsifiable part and the falsifiable part. Quantum computing theory is almost sure unfalsifiable, and is a machine design with the lowest testability in the history of physics. As Popper (1959) stated that the degree of universality and of precision of a theory increases with its degree of falsifiability. The lowest degree of falsifiability is accompanied by high risk and low strictness. The high risk of the unfalsifiable part protected by the Achilles mechanism has not been publicized. It has not been publicized the fact that the qubit reading step has become the core of the falsifiability of quantum computing. (3) The Feynman-Deutsch's $\left| \psi \right|^2$(qubit) reading hypothesis has not been thoroughly tested by experiments, but have not been publicized. (4) The Feynman-Deutsch theory does not express the ways in which all essentials of quantum computing can be built upon the basic assumptions. For any strict theory, major deficiencies like the above are unacceptable.

8.2 We propose a completely new research direction for quantum computing: the priority of quantum computing research is the inapplicability of Born Rule to quantum computing.

First, we show that for the two fundamental components of quantum computing, the scientific status of qubit reading takes precedence over the unitary transformation sequence, because the former is falsifiable and the latter belongs to the unfalsifiable part of quantum computing. Second, the inapplicability of Born Rule to quantum computing (i.e., the inapplicability of ${\left| \psi \right|^2}$ mapping) must take precedence over any other study of the qubit characteristics (e.g., qubit scalability, quantum gates and error correction), because the ${\left| \psi \right|^2}$mapping (or double ${\left| \psi \right|^2}$) hypothesis is the assumption that overrides Born Rule. Therefore, we propose a completely new research direction for quantum computing: the priority of quantum computing research is the inapplicability of Born Rule to quantum computing. The methodological error of the Feynman-Deutsch theory is to exclude the inapplicability of Born Rule (as the priority) from the research field.

8.3 Deutsch stated that it is shown that quantum computing is compatible with quantum mechanics with the principle. We show that quantum computing is incompatible with Born Rule. The root of everything wrong with quantum computing is the double probability density hidden in the technical scheme.

Deutsch stated that it is shown that quantum computing is compatible with quantum mechanics with the principle. Born Rule and Time Evolution Postulate are important components of quantum mechanics. The main authors of the Feynman-Deutsch theory for 40 years have not provided a proof of the compatibility of quantum computing with Born Rule and the related measurement postulates. Deutsch completely avoided the extraction of unitary transformation results in his paper. Obviously, he defaulted that the output probability density can map to the observation-space and to be read. In this paper we show that quantum computing is incompatible with Born Rule and the related three measurement postulates. Our proof consists of three parts. (1) We show that in the technical scheme of quantum computing, there is a strong constraint on Born Rule, that is, the double probability density hypothesis (or ${\left| \psi \right|^2}$ mapping hypothesis), which requires that there is such a mapping from CS_M to CS_C: ${\left| {{\psi _M}} \right|^2}\to{\left| {{\psi _C}} \right|^2}$, where ${\left| {{\psi _M}} \right|^2}$is the probability density of the wavefunction ${\text{a}}\left| 0 \right\rangle +b\left| 1 \right\rangle$ of the single-qubit, ${\left| {{\psi _C}} \right|^2}$ is the probability density of the corresponding outcomes within CS_C, and ${\left| {{\psi _C}} \right|^2}$ is equivalent to ${\left| {{\psi _M}} \right|^2}$. The Feynman-Deutsch theory claims that the algorithm output is provided by the probability densities of the corresponding qubits. The original Born Rule only asserts the existence of ${\left| {{\psi _M}} \right|^2}$, does not assert the mapping ${\left| {{\psi _M}} \right|^2}\to{\left| {{\psi _C}} \right|^2}$. We make the qubit-reading step transparent, and expose this hidden assumption: the double ${\left| \psi \right|^2}$ and the dependence of the algorithm output on the double ${\left| \psi \right|^2}$. We demonstrate that in the technical scheme of quantum computing it is assumed that the single-qubit carrier-symbol snapshot traceability is the basis for the realization of the double ${\left| \psi \right|^2}$. (2) We show that quantum computing is incompatible with Born Rule (i.e., Born's probability density rule and Postulates IV), and that quantum computing is incompatible with Postulates III and [illegible]. (3) We show that in Feynman Deutsch theory, Feynman-Deutsch's ${\left| \psi \right|^2}$(qubit) reading hypothesis is introduced to govern the qubit reading step, and this ${\left| \psi \right|^2}$(qubit) reading hypothesis is not a special case of Born Rule. We, using the S-G experiment and the chip engineer's contraction mapping experiment as “the empirical application”, experimentally falsify the single-qubit carrier-symbol snapshot traceability, and thus experimentally falsify the Feynman-Deutsch’s ${\left| \psi \right|^2}$(qubit) reading hypothesis. In this way, we show that quantum computing is incompatible with Born Rule and the related measurement postulates, and the introduced the Feynman-Deutsch’s ${\left| \psi \right|^2}$(qubit) reading hypothesis is also incompatible with quantum mechanics. The Feynman-Deutsch quantum computing theory is not feasible.

The focus of this paper is to show the incompatibility of quantum computing with Born Rule and related measurement postulates. Our proof shows that the root of all errors in quantum computing is the double probability density hidden in the technical scheme. We prove the fact that although algorithms are implemented in the name of quantum mechanics, and the algorithm’s output within CS_M is converted into the outcomes within CS_C in the name of quantum technology, we show that the "double ${\left| \psi \right|^2}$" is actually independent of Born Rule, independent of the quantum measurement postulates, and independent of quantum mechanics. The fact we prove is a milestone in the development of quantum computing that marks the transparency of single-qubit reading. The transparency demonstrates that the root of the tree structure of quantum computing involving qubit reading (double ${\left| \psi \right|^2}$) is actually independent of quantum mechanics.

8.4 Quantum computing is based not on quantum mechanics as expressed in mainstream textbooks but on custom-built quantum mechanics. Quantum computing is not a real branch of quantum mechanics.

We show that in the technical scheme of the quantum computing, for the single-qubit traversal, the time evolution in the absence of observation is assumed, and the predictable sequence of zero-life coupled symbols gap (including single-eigenstate gap) is assumed. The original Time Evolution Postulate does not assert the time evolution of the system in the absence of observation, does not assert the single-qubit stepwise time evolution Hamiltonian. Therefore, quantum computing is incompatible with Time Evolution Postulate, and the Feynman-Deutsch theory has never provided a proof of the compatibility of quantum computing with Time Evolution Postulate. The view that the Feynman-Deutsch theory has proved the compatibility of quantum computing with Time Evolution Postulate is completely wrong. Since the single-qubit time evolution belongs to the unfalsifiable part of quantum computing and is protected by the Achilles mechanism, we do not falsify the custom-built time evolution rule.

We show that even without considering the inapplicability of Time Evolution Postulate to quantum computation, the three quantum mechanical postulates listed in mainstream quantum mechanics textbooks (Postulate ▯underlying Born Rule, Postulate ▯ and Collapse Postulate ▯) have been tampered with in Feynman-Deutsch theory. For example, Collapse Postulate is modified to a custom-built collapse postulate: For quantum computing, if the measurement of the physical quantity Q on the system in the state $\left| \psi \right\rangle$ gives the result λ_n, the state of the system immediately after the measurement is $\left| {{\varphi _n}} \right\rangle$, and the collapsed snapshot λ_n can be traced from the measurement outcome within CS_C. In this way, we show that quantum computing theory is based not on quantum mechanics as expressed in mainstream textbooks, but on a custom-built quantum mechanics tailored for quantum algorithm. The view that the principles of quantum computing are derived from the mainstream quantum mechanics axioms is wrong. Quantum computing is a scientific invention that aims to describe manipulable qubits wearing eigenvalue-symbols based on custom-built quantum mechanics. Quantum computing is not a real branch of quantum mechanics.

8.5 The DiVincenzo criteria artificially increases the degree of falsifiability of quantum computing. All known quantum computing (Shor's factoring algorithm) experiments are invalid.

We show that all DiVincenzo criteria are not falsifiability criteria except qubit reading capability. Unfalsifiability criterion has no meaning for practical quantum computers. In fact, there is only one falsifiability criterion for quantum computing, that is, double probability density criterion, which ultimately is reduced to the single-carrier-symbol snapshot traceability. We propose single-qubit Postulate IV experiment (double probability density experiment) to be crucial experiment for quantum computing. The mistake of the DiVincenzo criteria is that the DiVincenzo criteria artificially magnify the value of qubit scalability and universal set of quantum gates, artificially increases the degree of falsifiability of quantum computing and greatly reduces the requirements for quantum computing implementation. We re-examined the effectiveness of three published quantum computing (Shor factoring) experiments [9, 10, 11]: our conclusions are as follows. The experiments satisfy the DiVincenzo criteria in principle and are valid in the sense of the DiVincenzo criteria. However, in the sense of falsifiability criterion and the traversal criterion, they are invalid. Optical quantum computing experiments B and C are actually quantum computing experiments of photon beams, and cannot be regarded as quantum computing described by the Feynman-Deutsch theory. The single-qubit identity criterion is an insurmountable obstacle to optical quantum computing (Shor factoring) experiments because it is impossible to prove the homogeneity of individual photons from entry to exit. Our conclusions hold for all quantum computing (Shor factoring) implementations.

8.6 The obstacles to the physical implementation of quantum computing cannot be overcome.

Our study shows that for quantum computing there are two principal errors: ${\left| \psi \right|^2}$ mapping and single-qubit stepwise time evolution. However, the single-qubit stepwise time evolution is protected by the Achilles mechanism. We focus our attention on ${\left| \psi \right|^2}$ mapping. Since the establishment of quantum mechanics, quantum computing is the only branch that has zero distance from Born Rule and related measurement postulates, the only branch that needs to modify the fundamental principle (Born Rule), and the only branch that hides the postulate-level principles in technical schemes. It has long been believed that quantum computing centers on quantum algorithm specified by u-transformation sequence. In fact, the full quantum computing tree structure shows that the real heart of the matter is ${\left| \psi \right|^2}$ mapping from CS_M to CS_C based on the single-qubit carrier-symbol snapshot traceability, which involves zeroing and reuse of single-qubit. A famous quote from Feynman is: nobody understands quantum mechanics (Feynman 1965). One can say that nobody understands time evolution with non-observables, but one cannot say that nobody understands Born

Rule, because Born Rule is a falsifiable theory. A famous quote from Feynman is: No one understands quantum mechanics. One can say that no one understands time evolution with non-observables, but one cannot say that no one understands Born's law, because Born's law is falsifiable. The ${\left| \psi \right|^2}$mapping hypothesis cannot be protected by the Achilles mechanism, and is falsified experimentally. The obstacles to the physical implementation of quantum computing cannot be overcome. The core values of quantum mechanics are to respect observables, but not to believe in non-observables; to respect the transmission of single-eigenvalue-snapshot in a statistical sense, and not to believe in the non-probabilistic traceability of single-eigenvalue-snapshot. Quantum computing takes the non-probabilistic traceability of single-eigenvalue snapshot and non-observable as fundamental principles, and in this way violates the basic idea of quantum mechanics. We have falsified the single-qubit eigenstate-symbol snapshot traceability by human experience of contraction mapping between spaces. A further proof of this point is given in the discussion in the next section.

9 A Development Of The Incompatibility Of Quantum Computing With Born Rule And The Related Postulates: Experimental Falsification Of The Single-particle Information-process Traceability.

9.1 The challenge of quantum computing to the principles of quantum mechanics forces us to propose a more general falsification target: single-particle information-process traceability.

Feynman and Deutsch's paper is considered the starting point for quantum computing theory. The more profound background of the Feynman-Deutsch theory is simulating quantum mechanics with computers. Feynman proposed “simulate with a computer a universal automaton or something the quantum-mechanical effects” in his 1981 paper. Deutsch, in his 1985 paper, stated a physical principle: every finitely realizable physical system can be perfectly simulated by a universal model computing machine operating by finite means. Simulating quantum mechanics and quantum computing can be regarded as two interrelated topics of the so-called "Feynman Deutsch thesis". Feynman pointed out that the key to simulating quantum mechanics is the simulation of quantum probability, but he focused on the time evolution of probability. In fact, the core of quantum mechanics is atomic theory. As Feynman said: what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis that all things are made of atoms… Obviously, if one expresses simulated quantum mechanics in the fewest words, then the phrase is simulating individual atoms and simulating the quantum probability of single-atom. The quantum probability is specified by Born Rule (including measurement postulates III and IV). Postulates III and IV state that the measurement result can be one of the eigenvalues $\{\lambda_n\}$ of the corresponding observable; the probability of obtaining eigenvalue-snapshot λ_n is $\left\langle {{\lambda _n}} \right|\left. \psi \right\rangle$. Eigenvalue snapshot of single-atom is the ultimate origin of simulating quantum mechanics. If the probability density of single-atom cannot be simulated, simulating quantum mechanics is impossible. Obviously, the fundamental question for simulating quantum mechanics is: Can the existence of eigenvalue snapshots be confirmed, can the existence of probability densities of simulated atom be confirmed in the simulation? These questions coincide exactly with the following questions required by quantum computing. (1) The measurement involves two coordinate systems CS_M

and CS_C, are the eigenvalue-snapshot and the carrier-snapshot within CS_M extrinsic or intrinsic to the coordinate system CS_C? (2) Is there a dual traceability of both carrier-snapshot and eigenvalue-snapshot for single-particle being measured. (3) What is the lifetime of the eigenvalue-snapshot, a zero-life snapshot (like the coupling symbol), or a snapshot with a very short lifetime, or a snapshot that can be placed on a conveyor? The above three issues have not been the focus of quantum physics for nearly a hundred years. However, simulating quantum mechanics and quantum computing force us to study these issues, drive us to study the deeper background of the double probability density (the single-qubit carrier-symbol snapshot traceability). This background consists of two topics. First, the single-qubit carrier-symbol snapshot traceability is associated with one of the most important problems of quantum mechanics (the physics version of Gödel's incompleteness theorem, see Section 11.1): the eigenvalue snapshot of the collapsed single-qubit within CS_M is the truth, but one cannot prove this truth within CS_C by means of the single-carrier-symbol snapshot traceability. Second, the chip engineer’s contraction mapping experiments, as the geometric basis for falsifying the single-qubit carrier-symbol snapshot traceability, require one to answer whether quantum information is intrinsic or extrinsic in the geometrical sense.

Therefore, the challenge of quantum computing and simulating quantum mechanics to the principles of quantum mechanics forces us to propose a more general falsification target: single-particle information-process traceability (i.e., direction constraint of single-particle information process). The falsification of the single-particle information-process traceability will provide an irrefutable basis for the falsification of quantum computing and for the negation of simulating quantum mechanics, which is defined as follows.

Single-particle information-process traceability (Direction constraint of single-particle information process): **(1) The information process from the state-space system to the observation-space system is an intrinsic process. The quantum information provided by quantum experiments is intrinsic information within CS_C. (2) For the state-to-observation information process, not only the statistical information of the quantum ensemble is traceable (reversible), but the single-object eigenvalue snapshot is also traceable.**

The falsification of the above proposition is equivalent to the corroboration of the following proposition.

Single-particle information-process non-traceability (Direction non-constraint of single-particle information process): **(1) The quantum information provided by quantum experiments is not intrinsic information, but is extrinsic information described by the observation-label carriers within the observation-space coordinate system CS_C (Bohr-Heisenberg information restriction). The information process from the state-space system CS_M to the observation-space system CS_C depends on the repeated invocation of the extrinsic information process; the depth-movement parameter of the observation-space coordinate system CS_C is discontinuous at the mesoscale** (**meso-scale contraction mapping experiment cannot be implemented). (2) For the state-to-observation information process, the statistical information of the quantum ensemble is traceable (reversible), but the single-object information snapshot is non-traceable (a single-particle-information conversion efficiency of 1 is impossible).**

The direction constraint of quantum information process can be understood as follows: snapshot information of a single quantum object cannot be transferred to the observation space coordinate system in a reversible manner, but statistical information of a large number of snapshot information can be transferred to the observation space coordinate system. The negative statement for the direction constraint is as follows. It is impossible to scale the Schrödinger superdepth map used by physicists without parameter interruption; it is impossible to achieve a single-particle-information conversion efficiency of 100% (without information dissipation).

9.2 The methodological basis of the falsification is the reproducible effect suggested by Popper. Outline of falsification methods using reproducible effect of traceability refutation.

Popper provides the methodological basis for the falsification of the single-particle information-process traceability: We shall take it as falsified only if we discover a reproducible effect which refutes the theory (Popper, 1959). The single-qubit carrier-symbol snapshot traceability has been falsified in Section 5. The basic proposition that has a higher degree of universality than the single-qubit carrier-symbol snapshot traceability is the single-particle information-process traceability, i.e., the direction non-constraint of the single-particle information-process. To take the falsification of the single-qubit carrier-symbol snapshot traceability have a higher degree of the universality, we need what Popper calls the reproducible effects that refutes the single-particle information-process traceability (hereafter this effect referred to as the reproducible effect of traceability refutation).

We will use the falsification method (reproducible effect of traceability refutation) suggested by Popper to falsify the single-particle information-process traceability. Because the overall picture of reproducible effect of traceability refutation in the later sections may be difficult to grasp, we introduce an outline of the falsification method. Here Popper's falsification method means that all known quantum experiments, in a “reproducible effect” way, refute the single-particle information-process traceability, that is, corroborate the direction constraint of quantum information process.

We will achieve the desired “reproducible effect” in the following way. (1) Feynman [15] said that the S-G experiment can serve as a prototype for the description of all quantum phenomena. We take the S-G experiment as a prototype for the single-particle information-process traceability. (2) We divide quantum experiments into three categories: (a) experiments involving quantum ensembles, (b) experiments involving individual particles of a quantum field, and (c) experiments involving a single trapped quantum system. We give representative experiments of these three categories to demonstrate that they falsify the single-particle information-process traceability in Popper’s “reproducible effect” way. (3) For each representative experiment, the steps to check areas follows. (a) Verify that the quantum information provided by the experiment is not intrinsic. ([illegible]) Verify the Bohr-Heisenberg quantum information restriction (see Section 10.3) is met, that is, verify all the quantum information snapshots provided by quantum experiment are not intrinsic information snapshots. ([illegible]) Verify the depth-movement parameter of the coordinate system is interrupted in the contraction mapping experiments. ([illegible]) Verify the single-particle information-process depends on the repeated invocation of the extrinsic information process. (b) Verify that the eigenvalue information snapshot of single-quantum-object is not traceable.

We give some basic concepts of the single-particle information process, which is based on the Banach contraction mapping principle, in Sections 9.3 and 9.4. All the representative experimental tests are in Sections 9.5 to 9.8.

9.3 The contraction mapping experiments and the Bohr-Heisenberg information restriction are the experimental basis of the falsification of the single-particle information-process traceability.

(1) Banach contraction mapping principle is a powerful tool for proving existence in metric space, and is a powerful tool for proving the existence of inverse element in physical space. The compressed image principle is also a powerful tool for proving the existence of inverse elements in physical spaces. We will use contraction mapping experiments to verify whether there is a non-intrinsic depth-movement process for two physical coordinate systems. The underlying idea of the direction constraint of quantum information process is that the discontinuity of the non-intrinsic depth-movement of coordinate system and the repeated invocation of the extrinsic information process must produce information dissipation and direction constraint of information process. Therefore, the contraction mapping experiment involved by the irreversibility of single-particle collapse information is the experimental basis of the direction constraint proposition of quantum information process. We may compare the single-particle information dissipation with the direction of natural processes described by the thermodynamics laws. Before Carnot, it was often claimed that a heat engine could achieve a heat-work conversion efficiency of 1. However, the second law of thermodynamics denied the reversibility of natural processes. Clausius showed that heat can never pass from a colder body to a warmer body without some other change. We focused our attention on whether the micro-scale contraction mapping experiment supports the geometric root of the single-particle information dissipation.

(2) The Copenhagen interpretation is generally accepted by physicists. The Copenhagen interpretation is often understood philosophically as "the reality is restricted to observations". There has been an academic disagreement among physicists about "the reality is restricted to observation". However, we can separate from the Copenhagen interpretation a pure-experimental statement, which is in fact the core of the Bohr-Heisenberg doctrine. Bohr [19] and Heisenberg [12] stated that the starting point of the Copenhagen interpretation is that all experience must ultimately be expressed in terms of classical concepts. Bohr and Heisenberg's statements implied that there is the restriction on quantum information. It is very unfortunate that Bohr and Heisenberg did not relate this restriction to the extrinsic geometric characteristics. We reinterpret Bohr and Heisenberg's statement as follows (we call this the Bohr-Heisenberg information restriction): the quantum information snapshots provided by quantum experiments is not intrinsic information snapshots, but extrinsic information snapshots described by the observation-label carriers in the observation-space coordinate system CS_C. Bohr-Heisenberg information restriction is not a philosophical proposition, but a proposition of physics-geometry, which emphasizes that quantum information snapshot is extrinsic information snapshot. The Bohr-Heisenberg information

restriction has been tested by logic and experiment. Therefore, the Bohr-Heisenberg quantum restriction is another experimental basis of the single-particle information-process non-traceability. All characteristics of the single-particle information-process non-traceability remain within the framework of the Copenhagen quantum mechanics. In fact, the mainstream quantum axiom system does not object to the direction constraint of quantum information process, because the mainstream quantum axiom system does not provide any knowledge of the single-particle information-process traceability, nor does it provide any knowledge of the single-particle information-process non-traceability.

9.4 Definition of the depth movability of a coordinate system: transformations of coordinate systems in the depth direction are neglected in modern physical theory.

We relate the dissipation of single-particle information process to a non-intrinsic depth-movement between two coordinate systems. For the depth-movability of the coordinate system, we need some definitions based on the Banach contraction mapping theorem.

The definition of the depth-movability of a coordinate system begins with a corresponding mathematical definition. Any spatial process can be described in terms of a coordinate system. The transformations of a coordinate system include transformations in the horizontal direction and in the depth direction. The major defect in existing physical theory (including the standard model and string theory) is that the transformations of coordinate systems in the depth direction are neglected. We recall that in intrinsic geometry, one can use the arc length as an intrinsic parameter of a curve; a coordinate system based on this intrinsic parameter moves along the curve and captures the intrinsic features of the curve. Movement of a coordinate system in the depth direction corresponds to a scaling down (or scaling up) of the coordinate system. We refer to such a movement as a depth-moving frame or depth movement of the coordinate system. For a depth-moving coordinate system, there exists a depth-movement parameter (similar to the arc length parameter of a curve) that serves as a scale factor for the coordinate carrier. In this paper, the default parameter is the scale factor of the coordinate carrier.

(1) **Mathematical definition of the depth movability of a coordinate system based on Banach contraction mapping theorem.** As shown in Fig. 6a, suppose that the depth-movement parameters of the two coordinate systems CS_1 and CS_2 are a_1 and a_2, respectively (for example, suppose that a_1 and a_2 represent the size scales of a star and a biological cell, respectively). If the Banach contraction mapping theorem holds for CS_1 and CS_2, we say that CS_1 is movable in the depth direction to CS_2 in a mathematical sense. Put it another way, if there exists a coordinate system CS_N that can always be scaled down until it is equivalent to CS_2 or scaled up until it is equivalent to CS_1 (i.e., $a_2 < a_N < a_1$ holds for its depth-movement parameter a_N), then we say that CS_1 is movable in the depth direction to CS_2 in a mathematical sense.

For example, consider the operation of zooming in by a factor of 10 on Google Maps, which means that the depth-movement parameter of the coordinate system changes from 1 to 0.1. As shown in Fig. 5a, let the coordinate carriers of CS_1 and CS_2 be denoted by x_1 and x_2, respectively. The validity of the correspondence between x_1 and x_2 is defined as the existence of a process in which there always exists a coordinate system CS_N (which satisfies the mathematical definition given above) such that its coordinate carrier x_N is a projected image of x_1 and x_2 is a projected image of x_N. In this case, we say that the validity of the correspondence between x_1 and x_2 is guaranteed by the traceability of the projected image.

(2) **Physical definition of the depth movability of coordinate system.** The statement that CS_1 is physically depth-movable to CS_2 means that all the correspondences involved by the contraction mapping in the mathematical definition can be confirmed in terms of common measurement tools (e.g., light signals) and that the depth-movement parameters can be obtained by measuring the coordinate differences between the two coordinate systems. A measurement refers to a length measurement performed by an observer along a geodesic in the sense of intrinsic geometry. It must be emphasized that the experimental verification of the Banach contraction mapping theorem must be realized by using common measurement tools. Hereafter, the term "contraction mapping theorem is experimentally valid" means that CS_1 can be moved physically to CS_2 in the depth direction.

Let us consider the movement (transformation) of a coordinate system along the depth loop in Newtonian physics. The observer uses a coordinate system to examine galaxies, in which the coordinate carriers are stars. The observer then scales down the coordinate system such that the coordinate carriers are the size of apples. The correspondence between these two coordinate systems is determined by light signals that are common to the two systems. The depth-movement parameter, representing the ratio of the star scale to the apple scale, can be obtained by means of an optical measurement. Since the movements (scaling down and up) do not produce any changes in the coordinates or coordinate differences, for the two coordinate systems moving along the apple-star-apple loop, the observations do not change.

(3) Definition of the depth movability of coordinate system in the sense of external verification. The physical theory of the physical process Y_2 associated with CS_2, denoted by $F_{ex}(Y_2)$, is assumed to depend on the depth movability of CS_2 to CS_1 (by mathematical definition). If $F_{ex}(Y_2)$ (including the depth-movement parameter) is valid for all the related physical experiments in CS_1, in which all the graphs and tables providing the data for these experiments are expressed only in terms of the coordinate carriers of CS_1 (see Fig. 6b), then we say that CS_1 is depth-movable to CS_2 in the sense of external verification.

The depth movability of a coordinate system depends on two factors: the projected image x_2 of the coordinate carrier x_1 of CS_1 must be traceable and the depth-movement parameter must be able to be measured internally. The depth immovability of a coordinate system represents the opposite case.

(4) Definition of the depth immovability of coordinate system. Suppose that the depth-movement parameters of the two coordinate systems CS_1 and CS_2 are a_1 and a_2, respectively. Furthermore, suppose that depth movability exists between the two coordinate systems CS_1 and CS_2 in the sense of external verification. If the coordinate systems satisfy the following three conditions, we say that CS_1 and CS_2 are depth-immovable. (a) ForCS_1 and CS_2, the Banach contraction mapping theorem is not valid. (b) Let x_1 and x_2 be the coordinate carriers of CS_1 and CS_2, respectively. The validity of the correspondence between x_1 and x_2 is described by the physical theory $F_{ex}(Y_{2,1})$ of the physical process $Y_{2,1}$ associated with CS_2, which depends on the depth movability between CS_1 and CS_2 in the sense of external verification. $F_{ex}(Y_{2,1})$ captures the correspondence between x_1 and x_2, whose validity is also described by the physical theory $F_{ex}(Y_{2,2})$ of another physical process $Y_{2,2}$ associated with CS_2. This process can be repeated to produce the sequence $F_{ex}(Y_{2,1})$, $F_{ex}(Y_{2,2})$, $F_{ex}(Y_{2,3})$... (c) For all experiments in this sequence, the scale of the relevant coordinate carriers is discontinuous at a limiting value M_0. In other words, the coordinate carrier for any coordinate system CS_m whose depth-movement parameter is less than M_0 can only be expressed physically by means of a coordinate carrier for a coordinate system whose depth-movement parameter is larger than M_0. In this case, we say that the depth movability of the coordinate system is discontinuous at the depth-movement parameter M_0, which is clearly at a mesoscopic scale (see Fig. 6c). We define this validity assessment as a process of extrinsic recursion.

The consequence of the depth immovability of a coordinate system is shocking; specifically, the inverse element of observation-label carrier is untraceable. As shown in Fig. 3d, due to the depth immovability of the state-space coordinate system, when the observer clicks on the "+" button in Map-3, he or she cannot trace back to the inverse element of the cat in Map-4; instead, he or she will obtain a series of graphs and tables of measurement data of atomic spins (the depth movability of the coordinate system is interrupted at parameter M_0). To illustrate the rationality of this claim of depth immovability, we present a detailed comparison of the state-to-observation spatial process with differential geometry. As shown in Fig. 6d, for a surface embedded in a 3-dimensional Euclidean space R_3, we simulate extrinsic recursion as follows. (1) A geometer is defined to live only on a tangent plane. Without knowing the embedded and connection paths shown in Fig. 6d, the geometer can only observe a discrete statistical projection of the local properties of the surface. Notably, for a geometer living in R_3, these connection paths would be internal paths; however, for a geometer on tangent plane T_0, these paths are immovable. (2) The geometer on tangent plane T_0 studies the properties of the surface either through discrete projections onto T_0 or from other tangent planes T_1, T_2, T_3, etc. (3) The geometer interprets these projections as quantum properties in another plane, which they call a microscopic plane. Finally, either through discrete projections onto T_0 or from other tangent planes T_1, T_2, T_3, etc., the geometer develops a quantum-like theory that characterizes the quantum properties of the micro-objects in the microscopic plane based on the invocation of observations and knowledge from the tangent planes. As illustrated in Fig. 6d, the quantum-like picture obtained by observer O_T on tangent plane T_0 is obtained by moving this coordinate system to a scaled-down version of the current observation-space coordinate system. However, observer O_T thinks that they moved this coordinate system to the real microworld coordinate system. The microscopic coordinate system considered in the existing quantum theory is obtained by neglecting experiments concerning the depth-movement parameter of the true state-space coordinate system and thus is an extrinsic coordinate system rather than an intrinsic coordinate system. This is an experimental fact that can checked to confirm its correctness. Now, let us consider a further comparison. Suppose that an observer becomes a wizard who can transform into an atomic-size observer, observe and record the collapse of potassium atoms in the microspace. According to the existing quantum theory, when the observer returns to the human-scale laboratory, the initial data will remain unchanged. The actual information process, however, is that the observer's initial data must go through multiple invocations of extrinsic information processes and cannot be free of information dissipation.

9.5 Reproducible effect of traceability refutation (1): the single-particle information-process traceability is falsified by the Stern-Gerlach experiment.

In this paper, the S-G experiment serves as a prototype for the experimental falsification of the single-particle information-process traceability. The procedure of the experimental test for the S-G experiment will be applied to other experimental tests in a “reproducible effect” way.

(1) We verify that the quantum information provided by the experiment is not intrinsic.

(□) The S-G experiment used the following classical devices: oven, inhomogeneous magnetic field, glass slide or screen of an ionization detector. The observation-label carrier corresponding to an atom is the deposited silver particle (or signal on the ionization detector screen). All the coordinate systems used by the observer are observation-space coordinate systems, and all the data used by the observer are provided by the observation-label carriers. Therefore, the S-G experiment satisfies the Bohr-Heisenberg information restriction required by the Copenhagen interpretation: the quantum information snapshot provided by the S-G experiment is not intrinsic information snapshot, but extrinsic information snapshot described by the observation-label carriers within CS_C. It must be pointed out that the microscopic coordinate system used by physicists in the existing quantum theory is not obtained by moving the observation-space coordinate system to the microspace but rather by extrinsically moving the current observation-space coordinate system. We refer to the coordinate system obtained by extrinsically moving the observation-space coordinate system as an extrinsic coordinate system (denoted by CS_{M-ex}).

(□) The readings recorded by observer are not obtained directly from the collapsed atom. In Section 5.2, we have shown that in the S-G experiment, there is no one-to-one correspondence with the single-carrier-symbol snapshot traceability from the collapsed atom to the observation-label carrier. In the S-G experiment, no information process smaller than the meso-scale was directly addressed. No signal crosses from the microspace into the current observation space to establish a one-to-one correspondence between the collapsed atoms and the observation-label carriers, and in this experiment, it is impossible to use a common measurement tool to do a contraction mapping experiment for a coordinate system smaller than the meso-scale. Therefore, in the S-G experiment, there is a non-intrinsic relevance between the state-space coordinate system CS_M and the observation-space coordinate system CS_C, the depth-movement parameter of the coordinate system is interrupted at the meso-scale (the scaling of the Schrödinger superdepth map is interrupted at the meso-scale).

(□) In the S-G experiment, the validity of the correspondence from the collapsed atom to the observation-label carrier can be directly verified, and depends on the repeated invocation of the extrinsic information process (that is, extrinsic recursion). For the S-G experiment, we present proof of this extrinsic recursion as follows. The correspondence between the potassium atoms (i.e., state-label carriers) and the corresponding observation carriers (i.e., observation-label carriers, the dot signals) on the detector screen cannot be directly confirmed by any signal response traversing the two coordinate systems. Thus, there is no continuous variation in the depth-movement parameter, as shown in Fig. 3d. In the S-G experiment, all the measured data for the state-label carriers are ultimately provided by the observation-label carriers, which are the signals on the detector screen. We denote the theory that describes the correspondence between the atoms (state-label carriers) and the observation-label carriers by $F_{ex}(Y_{2,1})$. $F_{ex}(Y_{2,1})$ involves a physical process $Y_{2,1}$, such as ionization or signal amplification. The ionization and signal amplification processes depend on the atomic orthogonal basis theory; therefore, $F_{ex}(Y_{2,1})$ is associated with known atomic orthogonal basis experiments. The validity of $F_{ex}(Y_{2,1})$ also requires an experimental verification of $F_{ex}(Y_{2,2})$. In turn, $F_{ex}(Y_{2,2})$ is also associated with atomic orthogonal basis experiments. Thus, the validity assessment finally leads to a series that involves invoking itself. For this series of checks, the physicist can work only in the observation-space coordinate system, and the data of the state-label carriers are provided only in terms of the observation-label carriers in the current observation space. These data are extrinsic data from outside the microspace rather than intrinsic data. According to the definition provided in Section 9.4, such a process invoking itself (process with the repeated invocation of the extrinsic information process) is an extrinsic recursion process. The termination condition of this extrinsic recursion process is that the series invokes all quantum experiments related to the state of a potassium atom, and the recursion process concerns known quantum atomic orthogonal basis experiments. The root cause of this extrinsic recursion is the fact that there are no such operable microscale information tools that provide information processes that occur within the state-space coordinate system. It must be emphasized again that the repeated invocation of the extrinsic information process involves physical processes in the detector, which are described by atomic theory, and thus is ultimately described by known atomic orthogonal basis theory.

(□) From (□) and (□), it can be inferred that the information process of a single atom must be accompanied by information dissipation, that is, the S-G experiment confirmed the direction of the information process. The S-G experiment can serve as a prototype for the information dissipation of a single quantum object. In the state space system, due to the state collapse, part of the potassium atoms collapses into {\left| \uparrow \right\rangle} (including “reorient” itself), and the other part of the potassium atoms collapse into {\left| \downarrow \right\rangle} (including “reorient” itself). In the observation-space system, one part of the observation-label carriers represents the state label \left| \uparrow \right\rangle, and the other part of the observation-label carriers represents the state label \left| \downarrow \right\rangle. The information on the collapse of the atom ensemble is transmitted to the observation-space system in terms of statistical information of the observation-label carriers. For any single quantum object, information dissipation occurs due to the discontinuity of the depth-movement parameter and the repeated invocation of the extrinsic information process.

The experimental fact is that in the S-G experiment, for a specified atom, the spin-label-carrier information and the spin-label information cannot be transmitted to the observation-space system as binary information. Namely, on the one hand, a signal on the screen (such as the observation label that represents $\left| \uparrow \right\rangle$) cannot be traced back to a certain state label $\left| \uparrow \right\rangle$; on the other hand, the observation-label carrier cannot be traced back to a certain state-label carrier. Specifically, in the atomic ensemble experiment, for a specified particle, signal information appears on the screen, and the spin-label-carrier information and the spin-label information are lost. In short, for quantum ensemble experiments, the information of a single particle cannot be transmitted to the observation-space coordinate system with an information conversion efficiency of 1. That is, the inverse element of the observation-label carrier (i.e., the corresponding state-label carrier) is untraceable, and the inverse element of the observation-label (i.e., the corresponding state-label) is untraceable.

(2) We verify that the eigenvalue information snapshot of single-quantum-object is not traceable. (a) The measurement is the process of converting the information snapshots within CS_M into the observed labels within CS_C, not a zero-lifetime process. We have already pointed out in section 5.2 that Collapse Postulate does not prohibit collapsed atom to be “reorient” itself after an instant. “Reorient” and re-collapse can induce new ionization and avalanche. Even for isolated atom, it is impossible to trace the eigenvalue snapshot of the atom within CS_M from the observation-label within CS_C. (b) The actual experimental fact is that the collapsed atom (potassium) interacts with the medium, and ionization and signal amplification produce the correspondence between the state carrier and the observable carrier. Once the interaction occurs, the potassium atom is no longer in the collapsed eigenstate $\left| \uparrow \right\rangle$ (or $\left| \downarrow \right\rangle$). The measurement that causes the collapse described by the extrinsic recursion process is a derived measurement performed in the extrinsic coordinate system CS_{M-ex}. For a specified particle, signal information snapshot appears on the screen, and the spin-label-carrier information snapshot and the spin-label information snapshot are lost. For quantum ensemble experiments, the inverse element of the observation-label carrier (i.e., the corresponding state-label carrier) is untraceable, and the inverse element of the observation-label (i.e., the corresponding state-label) is untraceable. The existence of a collapsed eigenstate snapshot of a single atom within CS_M is verified by the probability distribution of signal carriers in terms of the information process between CS_M and CS_C.

The information processes of the S-G experiment include the information processes of the atomic ensemble and the information process of a single atom (Fig. 4e). As is known, the data provided by the S-G experiment are consistent with the results derived from quantum theory. All quantum experiments were ultimately described in terms of observation-label information in the classical apparatus. The formalism of quantum mechanics is modeled from observations that occur in the classical apparatus in the observation-space system. In other words, the output information of the information process comes first; the theory of atomic ensemble derived from the output information comes second. Consequently, it is impossible to change the information of the quantum ensemble in the information process from the state-space system to the observation-space system. The S-G experiment shows that there is no information dissipation for the atom ensemble.

Finally, we conclude that the single-particle information-process traceability is falsified by the Stern-Gerlach experiment, that is, the direction constraint of single-particle information process survives the test of the Stern-Gerlach experiment.

9.6 Reproducible effect of traceability refutation (2): the single-particle information-process traceability is falsified by the wave experiment for fullerene.

Another representative example of the quantum experiments involving quantum ensembles is the wave experiment for fullerene (C60) [20].

(1) We verify that the quantum information provided by the experiment is not intrinsic. (□) The wave experiment for fullerene used the devices: an oven, two slits, a SiNx grating, a laser, a channeltron electron multiplier, and a conversion electrode. These devices are classical devices. The observation-label carriers describing the information of C60 molecules are the indicator signals provided by the channeltron electron multiplier. All the coordinate systems used by the observer are observation-space coordinate system CS_C, and all the data used by the observer are provided by the observation-label carriers. Therefore, this experiment satisfies the Bohr-Heisenberg quantum information restriction required by the Copenhagen interpretation: the quantum information provided by the fullerene wave experiment is not intrinsic information, but extrinsic information described by the observation-label carriers within CS_C. (□) The readings recorded by observer are not obtained directly from the C60 molecules. In the experiment, no information process smaller than the meso-scale was directly addressed. No signal crosses from the microspace into the current observation space to establish a one-to-one correspondence between the C60 and the observation-label carriers, and in this experiment, it is impossible to use a common measurement tool to do a contraction mapping experiment for a coordinate system smaller than the meso-scale. Therefore, in the wave experiment for fullerene, there is a non-intrinsic relevance between CS_M and CS_C, the depth-movement parameter of the coordinate system is interrupted at the meso-scale (the scaling of the Schrödinger superdepth map is interrupted at the meso-scale). (□) The correspondence from C60 molecule to the indicator signal provided by the channeltron electron multiplier is not an information process that can be directly verified. The validity check of the correspondence (the information process) from fullerene to the observation-label carrier depends on the repeated invocation of the extrinsic information process, which involves diffraction, ionization and signal multiplication. The extrinsic recursion process must ultimately be expressed in terms of atomic orthogonal basis experiments and theory. (□) From (□) and (□), it can be inferred that the information process of a single particle (C60) must be accompanied by information dissipation, that is, the wave experiment for fullerene confirmed the direction of the information process.

(2) We verify that the eigenvalue information snapshot of single-quantum-object is not traceable. Similar to the S-G experiment, the information snapshot of a single particle cannot be transmitted to the observation-space coordinate system with an information conversion efficiency of 1. For a signal provided by the channeltron electron multiplier (i.e., the observation-label carrier), its inverse element (i.e., the corresponding state-label carrier, a C60 molecule) is untraceable, and the inverse element of the

observation label (i.e., the corresponding position label) is untraceable. The appearance of the information snapshot of a single observation-label carrier means that the information of its inverse element (state-label information and state-label-carrier information) has been lost. Of course, the loss of the information snapshot does not affect the information generated by a large number of information snapshots, which can provide the information of the geometric structure of C60 molecule.

Therefore, the single-particle information-process traceability is falsified by the wave experiment of fullerene, that is, the direction constraint of single-particle information process survives the test of the wave experiment of fullerene.

9.7 Reproducible effect of traceability refutation (3): the single-particle information-process traceability is falsified by the neutrino experiment and high-energy particle measurement.

We re-examine the information process of the quantum experiments involving a single particle in the quantum field. Representative examples are a neutrino experiment [21] and the Large Hadron Collider beauty (LHCb) experiment.

(1) We verify that the quantum information provided by the experiment is not intrinsic. (□) The devices used in the neutrino experiment include a cylindrical stainless steel tank, ultrapure water, photomultiplier tubes (PMTs), a computer, and monitors. The observation-label carriers describing the information of neutrino are observation-label carriers (indicator signals from a PMT) within CS_C. All the coordinate systems used by the observer are observation-space coordinate system, and all the data used by the observer are provided by the observation-label carriers. Therefore, this experiment satisfies the Bohr-Heisenberg quantum information restriction: the quantum information provided by the neutrino experiment is not intrinsic information, but extrinsic information described by the observation-label carriers in CS_C. (□) The readings recorded by observer are not obtained directly from the neutrino. In the experiment, no information process smaller than the mesoscopic scale was directly addressed. No signal crosses from the microspace into the current observation space to establish a one-to-one correspondence between the neutrino and the indicator signal from a PMT, and in this experiment it is impossible to use a common measurement tool to do a contraction mapping experiment for a coordinate system smaller than the meso-scale. Therefore, in the neutrino experiment, there is a non-intrinsic relevance between CS_M and CS_C, the depth-movement parameter of the coordinate system is interrupted at the meso-scale. (□) The correspondence from the neutrino to the indicator signal provided by the PMT is not an information process that can be directly verified. The validity check of the correspondence (the information process) from the neutrino to the observation-label carrier depends on the repeated invocation of the extrinsic information process, which involves Cherenkov radiation and signal amplification. The extrinsic recursion process must ultimately be expressed in terms of atomic orthogonal basis experiments and theory. (□) From (□) and (□), it can be inferred that the information process of a single neutrino must be accompanied by information dissipation, that is, the neutrino experiment confirmed the direction of the information process.

(2) We verify that the eigenvalue snapshot of single-quantum-object is not traceable. Similar to the S-G experiment, the information of a single particle cannot be transmitted to the observation-space coordinate system with an information conversion efficiency of 1. For a single-particle experiment, there are two possibilities: (a) when the single-eigenstate information snapshot is transmitted to the observation-space system, the state-label-carrier information is lost; (b) if the experimenter confirms that the single particle is trapped, that is, the state-label-carrier information is locked, the single-eigenstate information snapshot is uncertain. It is impossible for a collapsed atom that passes through an ionization detector to maintain a particular eigenstate. That is, the neutrino does not remember that it was in the collapsed state (as Feynman said). Similarly, it is impossible for a neutrino passing through a dielectric medium to maintain a particular eigenstate in its trajectory. The neutrino's extrinsic signal-carrier trajectory describes its extrinsic physical quantity (such as energy). The neutrino in the experiment is not trapped, and state-label information is obtained by numerical analysis. The neutrino experiment is a measurement operation experiment. When the numerical analysis result of the observation-label is obtained (the moment when the single-eigenstate-label information snapshot reaches the observation-space system), the information snapshot of the inverse elements of the observation-label-carrier is lost, and the state-label-carrier is impossible to manipulate.

The above analysis of the information process is applicable to the state-to-observation process in the LHCb experiment (including Higgs particle measurements). Therefore, the single-particle information-process traceability is falsified by the neutrino experiment and high-energy particle measurement, that is, the direction constraint of single-particle information process survives the test of the neutrino experiment and high-energy particle measurement.

9.8 Reproducible effect of traceability refutation (4): the single-particle information-process traceability is falsified by the experiments involving a single trapped quantum system.

We re-examine the information process of the experiments involving a single trapped quantum system. A representative example is a photon-trapping experiment (called the Haroche experiment) [18].

(1) We verify that the quantum information provided by the experiment is not intrinsic. (□) The experiment inherently includes an experiment on the continuity of the depth-movement parameter. All the devices (a box for preparing Rydberg atoms, Ramsey cavities, a cavity for QND detection, an interferometer, an ionization detector, and a computer) are described in terms of the observation-space coordinate system. All the data used by the observer are provided by the observation-label carriers. The observation-label carriers describing the information of the photons are indicator signals in the form of red and blue bars for QND detection. Therefore, this experiment satisfies the Bohr-Heisenberg quantum information restriction: the quantum information snapshot provided by the photon-trapping experiment is not intrinsic information, but extrinsic information snapshot described by the observation-label carriers in CS_C. (□) The readings recorded by observer are not obtained directly from the photon. In the experiment, no information process smaller than the mesoscopic scale was directly addressed. No signal crosses from the microspace into the current observation space to establish a one-to-one correspondence between the

photons and the indicator signals, and it is impossible to use a common measurement tool to do a contraction mapping experiment for a coordinate system smaller than the meso-scale in this experiment. Therefore, in the photon-trapping experiment, there is a non-intrinsic relevance between CS_M and CS_C, the depth-movement parameter of the coordinate system is interrupted at the meso-scale. (☒) The correspondence from the photon to the classical indicator signal is not an information process that can be directly verified. The instantaneous trap of the photon is described by the information snapshots of the red and blue bars as the observation-label carrier information (a sudden change in the sequence of more than 2000 detection events); the information of the red and blue bars is obtained via repeated invocation of the extrinsic information process (involving the field ionization detector, Gaussian cavity mode, Ramsey interferometer, etc.). The extrinsic recursion process must ultimately be expressed in terms of atomic orthogonal basis experiments and theory. (☒) From (☒) and (☒), it can be inferred that the information process of a single trapping photon must be accompanied by information dissipation, that is, the photon-trapping experiment confirmed the direction of the information process.

(2) We verify that the eigenvalue information snapshot of single-quantum-object is not traceable. The information of a single particle cannot be transmitted to the observation-space coordinate system with an information conversion efficiency of 1. When the information of the red and blue bars (by means of numerical analysis) is obtained, the single-photon information snapshot and the eigenstate information snapshot of the photon before the repeated invocation of the extrinsic information process are lost. As we noted in Section 9.5, if the experiment confirms that the state-label-carrier information is locked, the single-eigenstate-label information snapshot is uncertain. For the trapped single photon (as the inverse element of the red and blue bars), its eigenstate information snapshot is untraceable.

Therefore, the single-particle information-process traceability is falsified by the photon-trapping experiment, that is, the direction constraint of single-particle information process survives the test of the photon-trapping experiment.

9.9 The direction non-constraint of single-particle information process is falsified; the direction constraint of single-particle information process is corroborated by surviving the test of all known quantum experiments. The implementation of ideal fidelity of single-bit collapse information is impossible.

We have shown that all known quantum experiments support the empirical fact: the Banach contraction mapping principle fails for meso-micro scale experiments, the depth-movement parameter of the observation-space coordinate system CS_C is discontinuous at the meso-scale, and the single-object information process is irreversible. The form of micro reality is not restricted to observation action of human observers, but to an empirical fact: the failure of Banach contraction mapping principle for meso-micro scale experiments. Therefore, the single-particle information-process traceability (the direction non-constraint of single-particle information process) is falsified in Popper’s “reproducible effect” way. The single-particle information-process traceability (the direction non-constraint of single-particle information process) has a higher degree of universality than the single-qubit carrier-symbol snapshot traceability.

Consequently, the physical implementation of the single-qubit carrier-symbol snapshot traceability is impossible, and the physical implementation of the Feynman-Deutsch theory is impossible.

9.10 The single-particle information-process non-traceability justifies why it is impossible to develop the quantum theory of single-particle.

In the past century, quantum theory has focused mainly on statistical ensembles. It is puzzling why researchers of quantum computing do not develop quantum theory for single-particle when the carrier-cell wearing state-symbol is the individual quantum object. Due to the wave-particle duality of micro-matter, the axioms of quantum mechanics relate only to the term "system" and not to "single-particle". The falsification of the single-particle information-process traceability demonstrates the following theoretical background for the impossibility of developing single-particle quantum mechanics. (1) For any orthogonal basis experiment involving a single quantum object, the experimenter cannot neglect the contraction mapping experiment in a mesoscopic scale. The contraction mapping experiment involves repeated invocation of the extrinsic information process, and the effectiveness of this recursion process depends on orthogonal basis experiments related to quantum ensembles. Therefore, orthogonal basis experiments for atom ensembles are more fundamental than orthogonal basis experiments for single objects. The orthogonal basis experiment for quantum ensembles comes first, and the orthogonal basis experiment for a single quantum object comes second. (2) Due to the direction constraint of the information process of a single object, the information process of a single particle must be accompanied by information dissipation. For a single trapped quantum object, the experimenter who performs the orthogonal basis experiment cannot obtain certain eigenstate information. As a result, there is no independent experimental foundation for a complete quantum theory of a single quantum object. An orthogonal basis experiment for a single simulated atom (a superconducting artificial atom) has been reported [22], and it was claimed that the experimental results demonstrate that the quantum jumps between eigenstates are random and discrete but may not be instantaneous. This experiment does not support the separability of the orthogonal basis. However, it must be noted that an atomic orthogonal basis experiment should be based on the information process from the state-space system to the observation-space system. However, the information process of the orthogonal basis experiment of a single simulated atom is a mixed information process between the observation-space system and the state-space system. It is unacceptable to use a simulation experiment that neglects the real information process from the state-space system to the observation-space system to negate the random and instantaneous characteristics of quantum jumps.

10 Results And Discussion.

10.1 The physical version of Gödel's incompleteness theorem: Quantum mechanical system that is restricted to operations within CS $_C$ cannot prove its own consistency.

Turing, in his 1936 paper, tried to relate the computability to “mathematics is logically inconsistent” proved by Gödel. Gödel's incompleteness theorems are among the most important results in modern mathematics, concern the limits of provability in formal axiomatic theories. Gödel's incompleteness theorem ended the study of grand unified theory of mathematics, the philosophical belief that "we will know and we must know" did not hold for mathematics research. It should be noted that the irreversibility of single-qubit collapse information is similar to Gödel's incompleteness theorem. Gödel’s proof explicitly produces a particular sentence that is neither provable nor refutable. This sentence is a “form” of the statement described in a formal language rather than its meaning. Now, we study the similarity of the irreversibility of single-qubit collapsed information with Gödel's incompleteness theorem. For the irreversibility of single-qubit collapse information, the specific sentence that is neither provable nor refutable is the binary information of the concrete physical reality (single-particle) in the micro-world. The term "neither provable nor refutable" means that the existence of eigenvalue-snapshot of single-qubit collapse within CS_M is the truth, but one, within CS_C, cannot prove the truth of eigenvalue-snapshot of single-qubit collapse. The irreversibility of single-qubit collapse information shows that nature, by means of the depth immobility of the coordinate system, has set a lower limit on the scale of manipulation achievable by a human observer, and has set the limits of provability in the logical system of quantum mechanics. Therefore, we regard the single-particle information-process non-traceability (the direction constraint of single-particle information process), which we have proved, as the physical version of Gödel's incompleteness theorem: quantum mechanical system that is restricted to operations within CS_C cannot prove its own consistency. Similar to the situation of modern mathematics, the physical version of Gödel's incompleteness theorem should end the study of grand unified theory of physics, and the philosophical belief "we will know, we must know" should not hold for physics research.

10.2 The feasibility of the simulation of quantum mechanics with computer: a counterexample.

The simulation of quantum mechanics with computer is one of the motivations for Feynman and Deutsch to propose a quantum Turing machine. What is the definition of a computer that can simulate quantum mechanics? Turing defined the computer using tape, bits (squares), symbols 0 and 1, scanning, etc. Turing's original bit is at the heart of the definition of computer. The authors of the Feynman-Deutsch theory assume that their computer simulating quantum mechanics consists of two-state observables with the carrier-symbol snapshot traceability. We point out that the core of simulating quantum mechanics is the traceability of eigenvalue-snapshot and the traceability of probability density of single simulated atom. Researchers who suggest the simulation of quantum mechanics with computer have not noticed the destructive power of the single-qubit carrier-symbol snapshot traceability to simulating quantum mechanics. Human-observers cannot prove the truth of eigenvalue-snapshot of single-qubit collapse within CS_C, cannot map the probability density of single-qubit to CS_C. The physical version of Gödel's incompleteness theorem shows that there can be no theoretical and experimental basis for the manipulability of individual quantum objects in the absence of the depth mobility of the coordinate system.

Now we present a counterexample. We have shown that based on the qubit definition, the algorithm in the Feynman-Deutsch theory can separate a single-qubit behavior track with zero-life symbol gaps. Therefore, in the Feynman-Deutsch theory, the designer can theoretically construct a simulated atom, which has a specific single-qubit behavior track, as follows. The designer makes a single simulated atom to be trapped, and compiles a sequence of its energy spectrum E_1, E_2, E_3...E_N. The designer makes the simulated atom to jump to energy levels E_1, E_2, E_3... E_N in sequence. In this way, based on the Feynman-Deutsch theory, the designer constructs a single deterministic simulated atom that contradicts quantum mechanics. This counterexample shows that a quantum computer based on the single-qubit carrier-symbol snapshot traceability and the single-bit stepwise time evolution must lead to a customized quantum mechanics containing deterministic atoms, a false quantum mechanics. Therefore, it is a failure to simulate quantum mechanics with two-state particles based on custom-built quantum mechanics principles.

Kuhn pointed out that the condition for the acceptance of the new paradigm is “anomalous results build up” and “science reaches a crisis”. The Feynman-Deutsch theory creates a new paradigm in quantum physics, as quantum computing creates theories that deal with the time evolution of unobserved single objects, and creates deterministic single simulated atom. However, for a century, there has been no “anomalous results build up” that requires scientists to develop the theory of single-bit time evolution in the absence of observation and to develop the theory of the simulation of quantum mechanics with computer. Quantum computing is not a new paradigm required by "science reaches a crisis".

10.3 The methodological mistakes of the Feynman-Deutsch theory.

Popper advocated falsifiability as the demarcation criterion of science from non-science. The methodological mistake of quantum computing theory is that the testability (falsifiability) of quantum computing has never been strictly addressed in an explicit way. The quantum computing, being almost sure non-falsifiable, is the theory with the lowest degree of falsifiability in the history of physics. Quantum computing theory is a non-transparent theory in which unfalsifiable part is not distinguished, and important falsifiable assumptions are hidden in technical schemes. The researchers spend most of their space on the unfalsifiable issues protected by the Achilles mechanism. Quantum computing theory is not a theory based on unbiased observation and systematic experimentation for the following reasons. (1) Quantum computing neglects almost all elementary experiments. The neglected experiments are as follows: contraction mapping experiments in meso-micro scale, double probability density experiment for single-qubit, zero-life-gap experiment for coupling between two unitary transformations of single qubit, experiment on the lifetime of a single eigenstate of single-qubit, identity authentication experiment for long-lifetime single photons and experiment on the lifetime of entangled pairs. From the standpoint of experimental physics, the neglect of these elementary experiments violates the scientist’s code and is unacceptable. (2) An impressive feature of the design of quantum computing is that it bases its important concepts on thought experiments, rather than on generally accepted laws of physics. Quantum computing theory uses the following thought experiments: EPR entanglement thought experiment (see

Section 10.4 for further discussion), Schrödinger's cat thought experiment, Feynman occupied-or-unoccupied thought experiment. The falsifiability and transparency of these thought experiments have never been seriously tested. (3) In quantum computing theory, it has never been announced that those computing principles have not been thoroughly tested by experiments, and those computing principles may involve matters that are not stated by the principles of quantum mechanics. In the formulation of the theory, one actually bypasses the most destructive concept: the single-qubit carrier-symbol snapshot traceability, ${\left| \psi \right|^2}$ mapping from CS_M to CS_C, the single-qubit stepwise time evolution in the absence of observation.

10.4 The falsifiability and non-transparency of quantum entanglement. The dependence of quantum entanglement on the single-qubit carrier-symbol snapshot traceability.

Quantum entanglement is assumed to be the hardware requirement for quantum computers. However, the main authors of quantum computing theory rarely discuss quantum entanglement in their papers. DiVincenzo did not include quantum entanglement in his list of criteria. In fact, the concept of quantum entanglement comes from the thought experiment, rather than the mainstream quantum mechanical system. Researchers in quantum computing have not studied the falsifiability and transparency of quantum entanglement. We need to make quantum entanglement in quantum computing completely transparent.

(a) The first issue of the transparency of quantum entanglement is the falsifiability of quantum entanglement. The basic questions are: what is the degree of falsifiability of quantum entanglement? Is there a postulate-level hypothesis hidden in the technical scheme? The idea of quantum entanglement is based on the EPR thought experiment [23]. The EPR experiment provides a prototype for the well-known entangled state ${\left| 0 \right\rangle _1}{\left| 1 \right\rangle _2}+{\left| 1 \right\rangle _1}{\left| 0 \right\rangle _2}$, for which the entanglement experiment assumes two microscopic observers within CS_M (often named Alice and Bob). When micro-Alice measures particle α and obtains collapse symbol "0", micro-Bob confirms that the symbol of particle β is "1", regardless of the influence of the information transmission process. Thus, the concept of quantum entanglement relies on single-bit state collapse and measurement in the sense of micro-Alice (Bob) within CS_M. Similar to the Deutsch testability statement, the entangled state must not be observed until the measurement has carried out since this would, in general, alter its relative state. Consequently, the entangled state is unfalsifiable until the measurement has carried out. It is easy to conclude that if there are only micro-observers micro-Alice and micro-Bob within CS_M, then the theory of ${\left| 0 \right\rangle _1}{\left| 1 \right\rangle _2}+{\left| 1 \right\rangle _1}{\left| 0 \right\rangle _2}$is an unfalsifiable theory. If macro-observers macro-Alice and macro-Bob within CS_C are introduced, and an additional condition is added, that is, micro-Alice and micro-Bob transmit the collapse-symbol snapshot of particle α and the collapse-symbol snapshot of particle β to macro-Alice and macro-Bob within CS_C, respectively, then, the measurement of entangled pairs (α, β) is an Achilles theory. That is, the entangled state is unfalsifiable before the measurement, and the measurement step (qubit reading) is falsifiable.

(b) The second issue of the transparency of quantum entanglement is the dependence of quantum entanglement on the single-qubit carrier-symbol snapshot traceability. The technical solution for quantum entangled pairs (a, b) consists of three parts: preparing entangled pair, the existence of entangled pair with non-zero-life within space-time, and reading entangled pair. Similar to quantum computing, it has been believed that reading entangled pairs is only a technical solution implemented by engineers. This is not the case at all. There is a postulate-level assumption hidden in the technical solution: macro-Alice and micro-Alice are the same human-being, and macro-Bob and micro-Bob are the same human-being. That is, the eigenvalue snapshots obtained by macro-Alice and macro-Bob can be traced back to the eigenvalue snapshots obtained by micro-Alice and micro-Bob, respectively. Precisely, the single-qubit carrier-symbol snapshot traceability is hidden in the technical solution of quantum entanglement. Transparency enables us to see that the information process between micro-Alice (Bob) and macro-Alice (Bob) directly touches the measurement postulates of quantum mechanics. As shown in Fig. 9.1, suppose that particles α and β are in the processor and memory of a quantum computer, respectively, and micro-Alice and micro-Bob are microscale observers within CS_M who are aware of the physical information of particles α and β, respectively. When the experimenter prepared the entangled pair (α, β), micro-Alice recorded the eigenstate label 0 for particle α, and micro-Bob recorded eigenstate label 1 for particle β. Suppose that at time t, human observers macro-Alice and macro-Bob observe particles α and β respectively to verify the entanglement pair (α, β), and ${\left| 0 \right\rangle _1}{\left| 1 \right\rangle _2}+{\left| 1 \right\rangle _1}{\left| 0 \right\rangle _2}$ collapses. Micro-Alice and micro-Bob transmitted their information to human observer macro-Alice and macro-Bob, respectively. Clearly, the condition for the experimenter to declare his entanglement experiment successful is that the information sent by micro-Alice to macro-Alice (the spin label 0 and carrier α) is transmitted with the single-qubit carrier-symbol snapshot traceability; the same is true for micro-Bob's messages to macro-Bob. Therefore, the realization of quantum entanglement relies on the single-qubit carrier-symbol snapshot traceability. The vector ${\left| 0 \right\rangle _1}{\left| 1 \right\rangle _2}+{\left| 1 \right\rangle _1}{\left| 0 \right\rangle _2}$with non-zero-lifetime is a separated vector in the eigenspace spanned by${\left| 0 \right\rangle _1}{\left| 1 \right\rangle _2}{\left| 1 \right\rangle _1}{\left| 0 \right\rangle _2}{\left| 0 \right\rangle _1}{\left| 0 \right\rangle _2}$ and ${\left| 1 \right\rangle _1}{\left| 1 \right\rangle _2}$. There has not been mainstream quantum mechanics textbook that lists the concept of quantum entanglement as a basic principle of quantum mechanics. As we all know, the basis of Einstein's space-time theory is the reversibility of the information process between two inertial frames. The quantum entanglement based on the EPR scheme clearly extrapolates the reversibility between inertial frames to the transmission of single-bit collapsed information. According to Einstein's thought, the recording of physical events relies on the information process from the physical event to the recording device. For macro-Alice and macro-Bob who record quantum entanglement within the coordinate system CS_C and adhere to Einstein's thought, they should not accept the assumption that the collapse information of the state ${\left| 0 \right\rangle _1}{\left| 1 \right\rangle _2}+{\left| 1 \right\rangle _1}{\left| 0 \right\rangle _2}$ recorded by micro-Alice and micro-Bob are equivalent to their records on the classical devices within CS_C. Confusingly, on the one hand, Einstein insists on the importance of signal transmission between the two observers' systems in his theory; on the other hand, the EPR scheme is unwilling to accept the fact that the information within CS_M cannot be transmitted to CS_C without information dissipation.

The above analysis leads to the following conclusions. (1) Without the introduction of macro-Alice (Bob), the occurrence of quantum entanglement within CS_M is unfalsifiable. If macro-Alice (Bob) who read the quantum entanglement is introduced, then the quantum entanglement is unfalsifiable within CS_C while entanglement reading is falsifiable within CS_C. (2) The theory of quantum entanglement, which belongs to single-particle quantum mechanics, is not based on quantum mechanics as described in textbooks, but on custom-built quantum mechanics. (3) The validity of quantum entanglement, which is used in the unfalsifiable part, is not possible to be falsified. But once the qubit reading capability is falsified, the introduction of quantum entanglement makes no sense.

A physical theory must be testable. Testability (falsifiability) is the demarcation criterion of science from non-science. It must be refuted that unfalsifiable theories are taken as the fundamental principles of quantum information machines.

10.5 The Feynman-Deutsch theory is a continuation of the hidden variable theory, an anti-Copenhagen interpretation theory.

For centuries it has been believed that there is no direction constraint of natural process from atoms to galaxies. In fact, the Copenhagen School has regarded the view that quantum information is intrinsic information either as suspect intuitively or even as falsehoods. Based on systematic experiments, in an intellectually honest way, the Copenhagen interpretation expresses the non-intrinsic characteristics of quantum information. Whether the quantum information provided by quantum experiment is intrinsic or extrinsic should be completely determined by experiment. This is not a philosophical problem, but a purely physical problem. Chip engineer’s contraction mapping experiments demonstrate the impossibility of a physical realization of Banach contraction mapping principle at the meso-micro scale. This impossibility justifies the Copenhagen interpretation's insistence on the non-intrinsic character of quantum information. The Copenhagen interpretation is a correct empirical model, while other interpretations (such as multi-world and decoherence) are idealist-physicist’s philosophical models. Heisenberg pointed out that the word “happens” can apply only to the observation, not to the state of affairs between two observations. Quantum computing theory, which actually claims that what happens in the unfalsifiable quantum process between two successive observations can be described and manipulated, is the continuation of the hidden variable theory. The important differences between quantum computing theory and hidden variable theory are as follows. The hidden variable theory is an unfalsifiable theory. The Bell inequality experiment is unfavorable to the hidden variable theory, but proponents of the hidden variable theory can still modify their theory to avoid being refuted. Quantum computing theory has a falsifiable part, and the Achilles mechanism does not protect Custom-built Born Rule (i.e., Feynman-Deutsch’s qubit reading rule) from refutation.

10.6 The importance of Banach contraction mapping theorem for directional constraint of space processes cannot be underestimated. The importance of the physical version of Gödel's incompleteness theorem cannot be underestimated. Neglecting Banach's contraction mapping experiment for the Standard Model and string theory is unacceptable.

This paper actually presents an important topic: among the four great theories of physics, does thermodynamics alone involve the direction of natural processes? Whether quantum mechanics follows thermodynamics is a doctrine that addresses the direction of natural processes. For quantum mechanics, the symmetry constraint alone is insufficient; there should also be constraints on space depth processes. The Banach contraction mapping theorem (Banach fixed point theorem) is the only important principle in mathematics that provides the depth relationship between two coordinate systems. The importance of the depth processes between coordinate systems and the importance of the contraction mapping theorem have been ignored. The contraction mapping theorem has been confirmed experimentally for the following sequence of coordinate systems: coordinate system with planets as a coordinate carrier, human coordinate system, and chip engineer's coordinate system. Whether the contraction mapping theorem holds experimentally in meso-micro scale is an important pure-physical issue. It is unreasonable to reject the verification of the contraction mapping theorem in meso-micro scale. An important tenet of the scientist’s code is to not neglect elementary experiments. This paper presents a criterion for the reliability of any physical theory: the reliability of a theory is inversely proportional to the number of elementary experiments that it neglects. The compression mapping experiment in meso-micro scale, which is associated with the physical version of Gödel's incompleteness theorem, deals a powerful blow to many existing theories (e.g., quantum computing, the Standard Model, and string theory). Quantum mechanics requires not only the laws of the state vector and the Hermitian operator but also the laws of the information process from the state-space coordinate system to the observation-space coordinate system. We raise the following questions. Is the Standard Model an experimental science? If so, do we have a reason to neglect the contraction mapping experiment in meso-micro scale? If the Standard Model does not the contraction mapping experiment in meso-micro scale, then it must state why Higgs particles, the state-label carriers of which are untraceable, can be considered the ultimate units of the matter world. Does the contraction mapping experiment in meso-micro scale affect the understanding of the gauge groups? String theory neglects all elementary experiments and thus has the lowest reliability among all physical theories. We ask the following questions. Can the string coordinate system and the observation-space coordinate system move intrinsically and freely within the same figurative Google Map? Do we have a reason to neglect elementary experiments (the compression mapping experiment in meso-micro scale)? How can mathematicians define the string coordinate system and strings in an interrupted Google Map? For any unified theory based on differential geometry (including gravitation theory) that assumes a coordinate system moving intrinsically and freely within the same figurative Google Map, the legitimacy of its elementary experiments must be re-examined. The physical version of Gödel's incompleteness theorem based on the compression mapping experiment in meso-micro scale refutes the grand unification theory. By the direction constraint of the quantum information process, no workable experimental foundation within current observation-space can ever be strong enough to prove or disprove the ultimate origin of single quantum object. Nature allows neither machine with a heat-work efficiency of 1 nor quantum information machines that violate Born Rule and the physical version of Gödel's incompleteness theorem. The proofs in this paper show that the compression mapping experiment in meso-micro scale and the physical version of Gödel's incompleteness theorem are more profound principles of quantum physics.

Abbreviations

S-G experiment, Stern-Gerlach experiment; EPR, a thought experiment and argument proposed by A. Einstein, B. Podolsky, and N. Rosen [23]; CSC, the current human observer's coordinate system (observation-space coordinate system); CSM, the coordinate system of the state space; CSM-ex, the extrinsic coordinate system obtained by extrinsically moving the observation-space coordinate system in the depth direction.

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Competing interests

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Authors' contributions

Bowen Liu is the sole author of this article (including the figures) and is responsible for its content.

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Figures

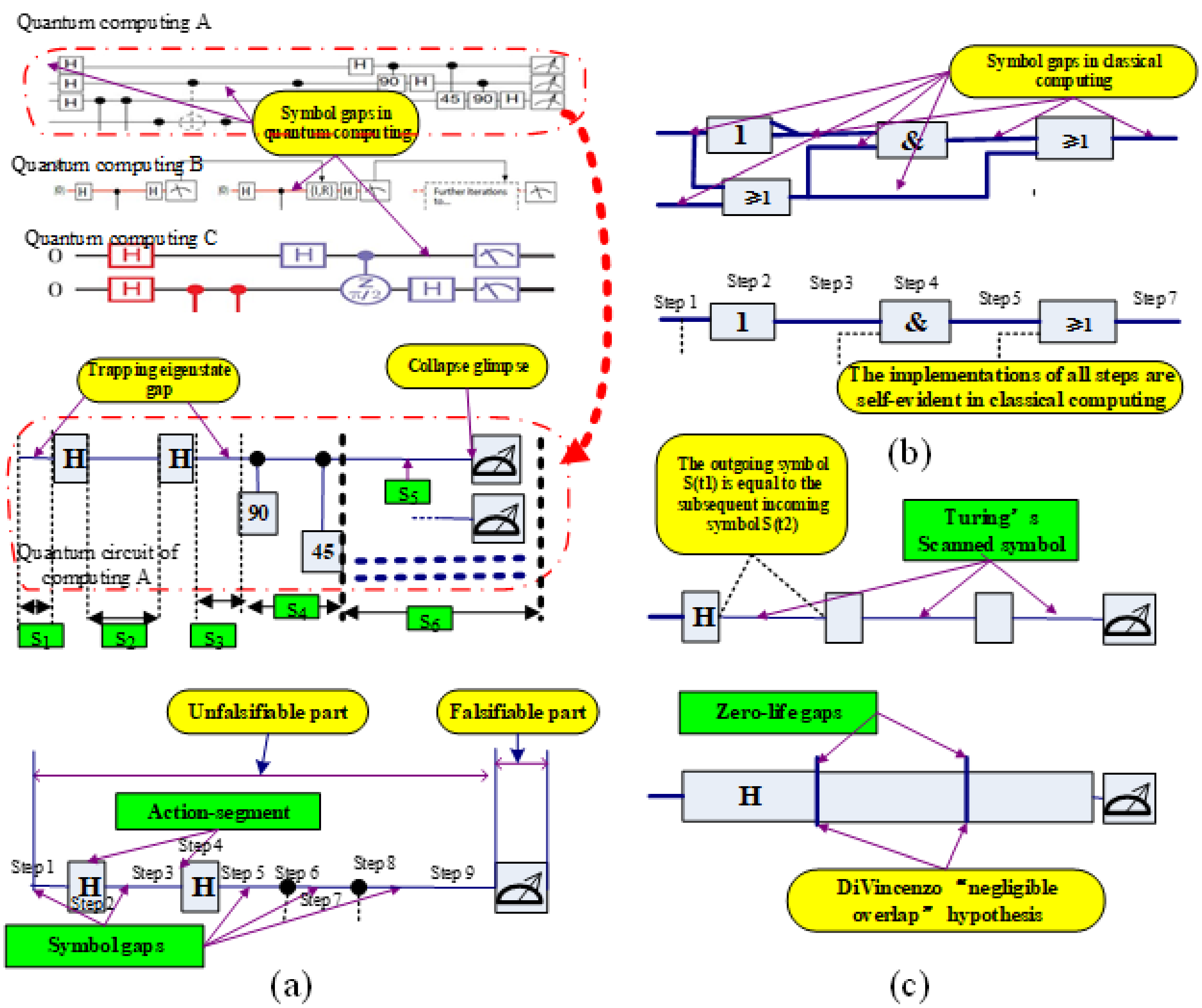

Figure 1

The falsifiable part and the unfalsifiable part of the Feynman-Deutsch theory must be distinguished. In the unfalsifiable part the Feynman-Deutsch theory taboos Turing’s term "scanned symbol" involving single-particle determinism. (a) Quantum computing is decomposed into irreducible elements in the reported quantum computing experiments A, B and C: action-segments, symbol gaps and collapse glimpse. The implementation of each element in quantum computing is not self-evident. **(b)** Classical computing is decomposed into irreducible elements: action-segments and symbol gaps. The implementation of each element in classical computing is self-evident. **(c)** A principle-level hypothesis, DiVincenzo's "negligible overlap" hypothesis, is hidden in the technical scheme of the Feynman-Deutsch theory. The coupling symbol is simplified as zero life one; the whole timeline is filled with non-zero life action-segments.

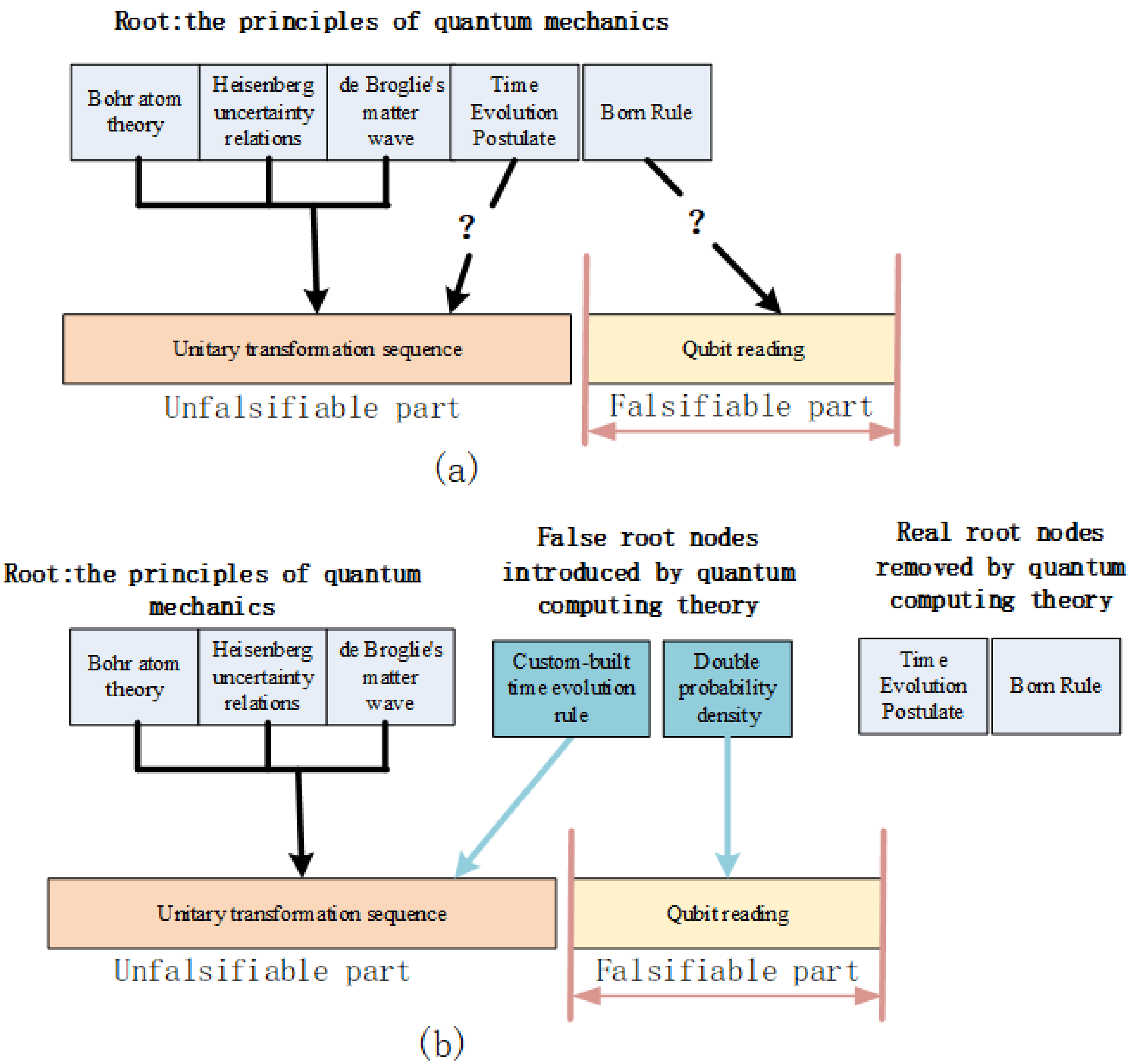

Figure 2

The Feynman-Deutsch theory provides a wrong tree structure of quantum computing. (a) the theoretical scheme of quantum computing is not the whole of the tree structure of quantum computing. **(b)** Born Rule (including the related measurement postulates) is removed from the root of the tree structure of quantum computing and replaced by the double $|\psi|^2$ hypothesis.

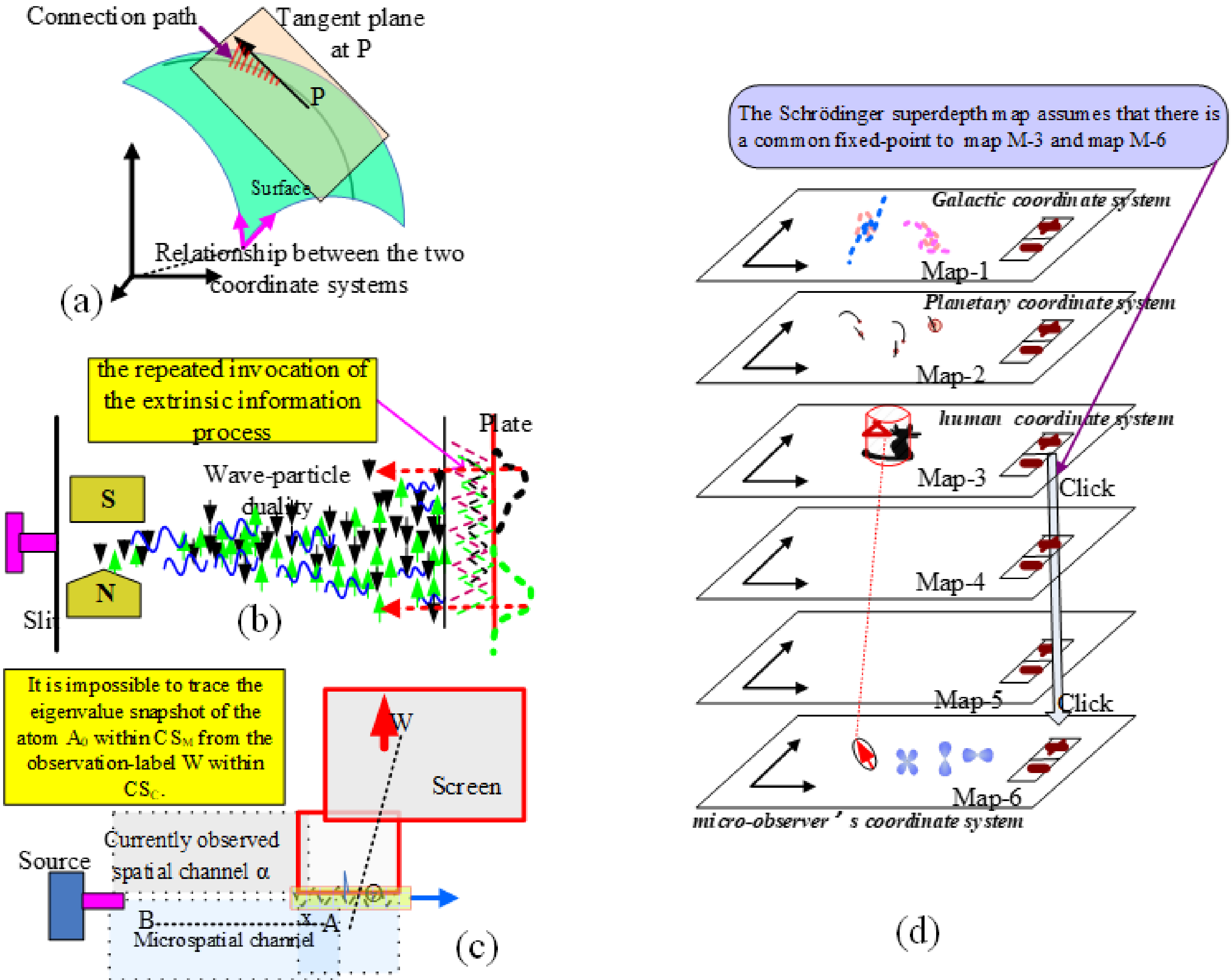

Figure 3

For the single-qubit carrier-symbol snapshot traceability, the S-G experiment and the chip engineer's contraction mapping experiments are the crucial. (a) To compare the spatial channels in differential geometry with the state-to-observation spatial channel. **(b)** There is no one-to-one correspondence between the microscopic state-label carriers and the observation-label carriers with the single-qubit carrier-symbol snapshot traceability. **(c)** Even for an isolated atom, it is impossible to trace the eigenvalue snapshot of the atom A_0 within CS_M from the observation-label W within CS_C. **(d)** For Map-1, Map-2, Map-3 and Map-4, the Banach contraction mapping theorem holds experimentally. There is no common fixed-point to map M-3 and map M-6.

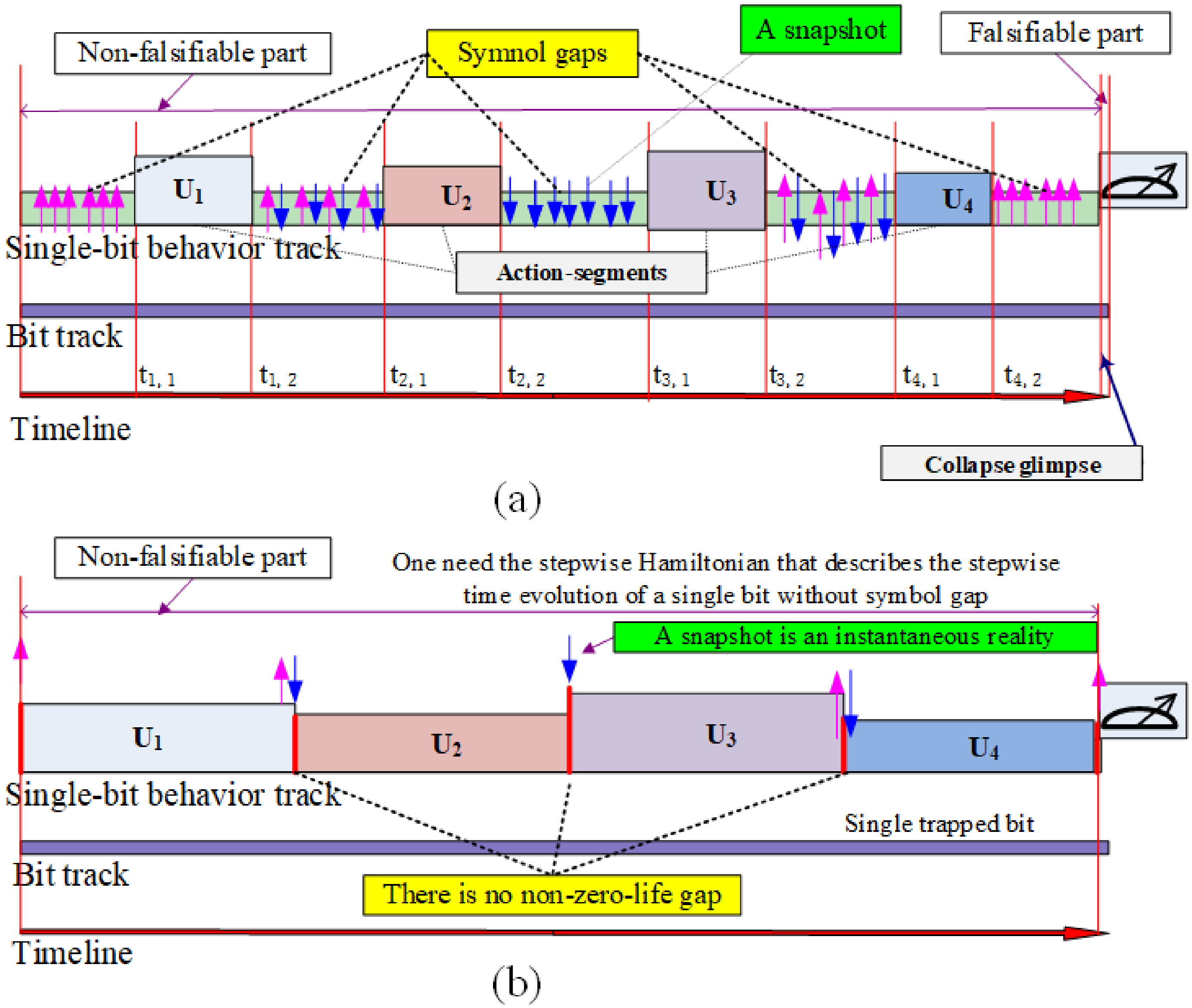

Figure 4

The Feynman-Deutsch theory requires changes to the existing Time Evolution Postulate. (a) For the single-bit entry-to-exit traversal, the timeline has one behavior track and one bit track; the image of the bit track is a straight line. **(b)** The Feynman-Deutsch theory requires to change the axiomatic system of quantum mechanics by adding new auxiliary hypothesis, which describes the single bit stepwise Hamiltonian without symbol gap.

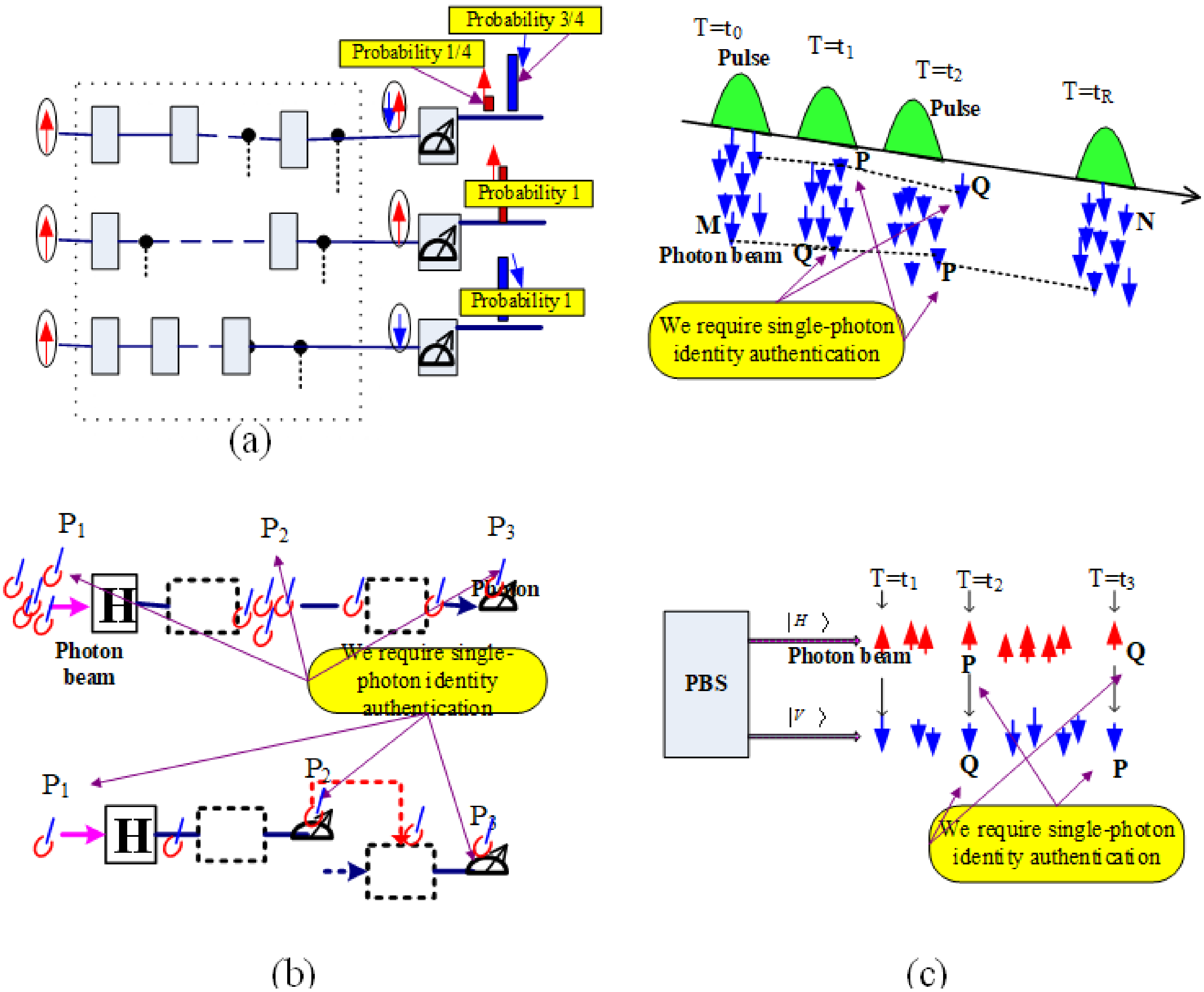

Figure 5

The quantum computing (Shor factoring) experiments A, B, and C are invalid in the sense of falsifiability criterion and the traversal criterion. **(a)** The crucial experiment for the realizability of quantum computing is the single-qubit postulate IV experiment. **(b)** The single-bit identity authentication requires proving that the single photons P_1, P_2 and P_3 are the same photon. **(c)** For a single photon it is infeasible to confirm the homogeneity of individual bits from entry to exit.

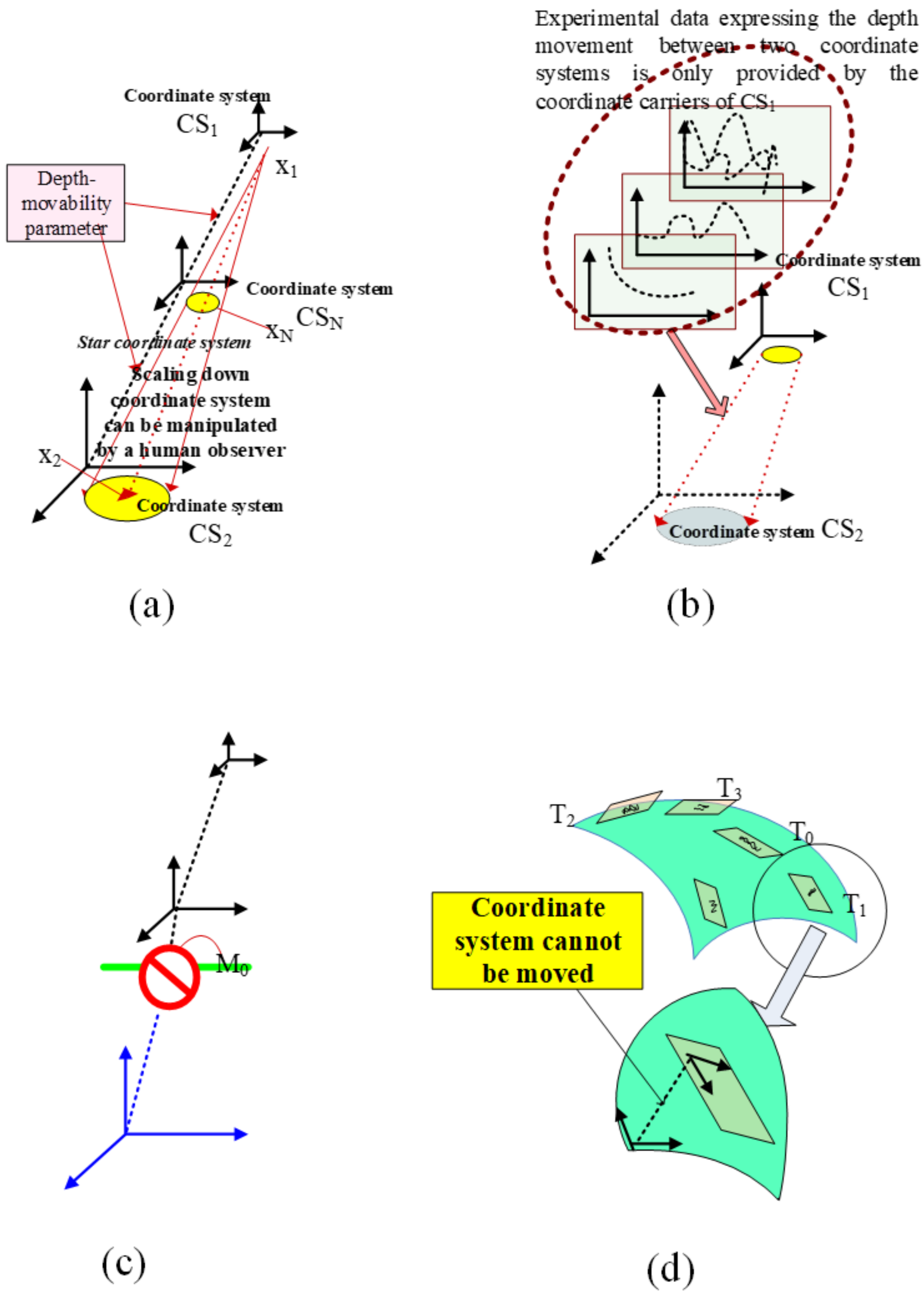

Figure 6

The direction of the information process in quantum experiments involves the non-intrinsic relevance between the state-space coordinate system and the observation-space coordinate system. (a) Definition of the depth movability of a coordinate system: depth-movement parameters are obtained by measuring the coordinate differences between two coordinate systems. **(b)** The depth movability of a coordinate system in the sense of external verification. **(c)** The depth movability of coordinate systems is interrupted at the meso-scale at the depth-movement parameter M_0. **(d)** To simulate extrinsic recursion: for a geometer living on tangent plane T_0, there may be a quantum-like theory since the two coordinate systems are intrinsically immovable.