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Why Can’t Humanity Make the Imaged Quantum Computer?

Rock Mountains*, Rock Mountains, Jr.**
*Boeing Commercial Airplanes
Email: rockmout385@gmail.com)
** Boeing Commercial Airplanes
Email: flying4dragon@gmail.com)

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Abstract:

In this article, Authors investigate the concept and origination of quantum computer through the basic theory of quantum mechanics. After comparing this type of quantum computer with the classic computer in principle, it is concluded that the currently imagined quantum computer could not be made as lacking of solid theoretical foundation.

Keywords — **Quantum Computer, Qubit, Classic Computer.**

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I. INTRODUCTION

Regarding the reports on the making of Quantum Computer, there have been a large number of reports, papers and discussions in many academic conferences around the world, media in various languages, and the Internet in recent years. Judging from these articles and reports, the main focus is to report on the progress of quantum computer (certain hardware and software) engineering research and manufacturing. Few articles analyse the feasibility of quantum computer research and manufacturing from the perspective of combining engineering and quantum mechanics basic theories.

The purpose of this article is to try to explore the feasibility of the currently conceived quantum computer manufacturing from the perspective of combining engineering and the basic theories of quantum mechanics, that is, whether human beings can finally successfully manufacture a quantum computer that can be put into practical use, and thus push the civilization of human society one step forward. Because if mankind has invested a lot of money and time, it is impossible to produce a quantum computer in the end, then quantum computer will become the second "perpetual motion machine" in human history, and it will be another huge loss for mankind.

First, the author is full of respect for the scientists and engineers who have been engaged in the theoretical research and manufacture of quantum computers from all over the world for many years, without any offense;

Secondly, the views in this article are only the authors’ personal statement, but to express the authors’ own views and opinions in a scientific manner that seeks truth from facts;

Third, the author tries his best to use non-professional language and vocabulary to describe quantum computers and quantum mechanics. However, in some places, it is still difficult to avoid the use of certain professional terms. I hope readers will understand.

II. GROUPING OF THE SCHOOLS OF QUANTUM MECHANICS

Before starting to discuss quantum computers, we first make a simple division of quantum mechanics theory. This division is mainly based on different physicists' views on quantum mechanics, and nothing else.

Based on this standard, the theory of quantum mechanics can be roughly divided into two groups:

The first group is mainly the Copenhagen School represented by Bohr, Heisenberg and Born. They conducted a theoretical analysis and summary of the early quantum experiments, called the interpretation or interpretation of Copenhagen quantum mechanics, which is called Interpretation in English.

The second group is mainly based on the theoretical analysis and summary of early quantum experiments by another part of physicists represented by Einstein, Schrödinger and De Broglie.

These six are all Nobel Prize winners in physics and have all made great contributions to the development of quantum mechanics. Therefore, they are all on the same level.

The theories of the first group and the second group are more similar and contradictory in many basic aspects.

For example, the famous Schrödinger cat is a thought experiment proposed by Schrödinger, a member of the second group, who developed Einstein's ideas to oppose the theory of the first group.

For another example, the concept of quantum entanglement, which is very hot today, comes from the members of the second group. In fact, the quantum entanglement thought experiment, or EPR thought experiment, was first proposed by the famous physicist Einstein of the second group and his two assistants, and later developed by Schrödinger against the first group of theories.

Regarding the differences and similarities between the first group and the second group theories, this article does not want to discuss further. Interested readers can directly read related articles and books, including Chinese or English versions. If possible, it is recommended to read the German version directly.

According to this division method, the whole theory of quantum mechanics is actually composed of two parts: the theory of the first group (the Copenhagen theory) and the theory of the second group (may be called the theory of Einstein and Schrödinger for the time being).

If expressed by a formula, it can be written as a formula as follows:

Quantum mechanics theory = Copenhagen's theory + Einstein/Schrodinger's theory

Based on the above formula, the Copenhagen School's theory is only one school of the quantum mechanics school, and it cannot represent the entire quantum mechanics theory. It is just a "one" if it is described in current online language.

In particular, it should be pointed out that because the two groups of theories are not strictly distinguished, it has caused great troubles to the scientific teaching and popularization of quantum mechanics.

For example, when people talk about quantum mechanics, they always take it for granted that the Copenhagen Doctrine represents the entire quantum mechanics, and the Copenhagen School’s theory is the authenticity of quantum mechanics. In the current textbooks of quantum mechanics, when explaining quantum theory, most of them follow the Copenhagen Doctrine and regard it as the authentic interpretation of quantum mechanics. However, the status of this so-called authentic explanation in quantum mechanics and science is becoming more and more like a religion, not only can not be questioned, but even to the point of compulsory brainwashing of students. For example, in the teaching of quantum mechanics, when facing the Copenhagen School questions raised by students, professors often avoid answering positively, and even warn students "Don't ask too much, just count!". Even if the Copenhagen School cannot "explain" why it is like this, it can only "tell you" that it is like this. For example, in the face of the famous double-slit experiment and wave-particle duality, it can only be expressed in terms of both being and being.

Therefore, when talking about quantum mechanics, it is better to distinguish this. For example, when some articles talk about the success of quantum mechanics in guiding the development of engineering with great progress, many people take it for granted that it is the success of the Copenhagen school because they do not specify the theory of that school. But in fact it is not.

III. THE ORIGIN OF THE CONCEPT OF QUANTUM COMPUTER

In 1981, the first International Conference on Computational Physics was held at the famous university MIT. During the conference, Richard Feynman, a well-known American theoretical physicist and Nobel laureate, proposed a novel idea of using quantum systems to realize general-purpose computing. He believes that if a computer composed of subsystems is used to simulate quantum phenomena, the computing time can be greatly reduced. In the second year, in 1982, the International Journal of Theoretical Physics, "International Journal of Theoretical Physics", please refer to Reference (1), published Feynman's "Simulating physics with computers" at the conference report. Therefore, the concept of quantum computers was born.

It should be emphasized here that Feynman proposed the concept of quantum computer based on the Copenhagen School. That is, the concept of quantum computer is proposed based on Copenhagen's superposition state theory. In the last part, we have explained that the Copenhagen School is only a school of quantum mechanics, and the foundation of this school is challenged by the theories of Einstein and Schrödinger. In particular, the famous Schrödinger cat challenged this theory. Therefore, the basic theoretical basis of quantum computers is not solid, and it is not entirely based on impeccable experiments, but based on the assumptions of a certain school.

IV. THE DEVELOPMENT OF QUANTUM COMPUTER

After Feynman put forward the concept of quantum computer, some countries, universities or laboratories, especially in recent years, many large international multinational companies have invested in the field of quantum computers. Of course, everyone uses different quantum physics systems to construct quantum computers. For example, the two orthogonal polarization directions of photons; the spin direction of electrons in the magnetic field; the two nuclear spin directions; the two different energy levels of the quantum in the atom. In short, various ways are being explored. For now, there is no definite answer as to which physical system is more suitable for quantum computers. But no matter what approach is adopted, the most basic point is the same: the most essential feature of quantum computers in these ideas is the use of quantum superposition.

According to the papers and reports published so far, the quantum computer being constructed by people is similar to a classical computer in principle: it is also a physical device for logical operations, storage and processing of information. The difference is that this physical device processes and calculates quantum information and runs quantum algorithms.

V. A BRIEF SUMMARY OF THE PRINCIPLES OF QUANTUM COMPUTERS

In order to understand the working principle of quantum computers, a simple engineering explanation is now based on classical computers.

Classical computer: Classical computer is a binary number system and is based on the basic unit (bit) in the computer to perform operations. Each "0" or "1" is a basic unit. The basic unit is the smallest unit of data storage. In other words, a classic basic unit can only have a certain "0" or "1" state in a certain time. Pay attention to the word "or" here.

Quantum computer: According to people's current thinking, quantum computer is also a binary number system, and is based on the basic unit (qubit) of the computer to perform operations. In each quantum basic unit, the states of "0" and "1" can be stored at the same time. Note the words "simultaneous" and "and" here.

The difference between a classical computer and a quantum computer is that the basic unit of a classical computer can only store one of "0" or "1" at a certain time; while the basic unit of a quantum computer can store both "0" and "1" at the same time. The difference between the two computers is the difference between "or" and "and":

Classic computer: "0" or "1";
Quantum computer: "0" and "1".

Then you can simply calculate. In a classical computer, if there are K classical basic units, it can only store K units of information at the same time; in a quantum computer, for K quantum basic units, they can store 2^K at the same time unit information. As the number of quantum basic units increases, the amount of information can increase rapidly.

To realize quantum computing with a quantum computer, it must also complete its calculations in three steps like a classical computer:

The first step is to construct a quantum basic unit;

The second step is to manipulate the quantum basic unit so that the "0" and "1" states exist at the same time;

The third step is to combine K identical quantum basic units to form a quantum computing system, so as to realize the supercomputing capability of a quantum computer.

Therefore, a quantum computer does not only contain one quantum basic unit, it is a physical system that contains multiple quantum basic units combined together.

The most difficult part of building a quantum computer is the first step, that is, a quantum basic unit must be constructed. This unit must allow the "0" and "1" states to exist at the same time. Note that this requirement must exist "at the same time"! If it does not exist "simultaneously", then this is not a quantum basic unit, but a classical basic unit.

In the second step, people conceive of using a quantum processor to operate to realize the construction and manipulation of each quantum basic unit. It requires that in the quantum basic unit, "0" and "1" must exist at the same time, that is, artificially forming a quantum superposition state and maintaining stability. If "0" and "1" cannot exist at the same time, then no matter how high the accuracy of this quantum computer is, it is essentially a classical computer.

Readers may sometimes see certain reports on the internet that quantum computers with thousands of quantum basic units have been built, and so on. This gives people the impression that a quantum computer will be built right away, which is very encouraging. In fact, this is the third step in the construction of a quantum computer, and it is the easiest to implement in the three steps of building a quantum computer. That is, regardless of whether the manufactured quantum processor meets the standards, mass production will take place first!

Now we use the terms of quantum mechanics theory to describe the principles of quantum computers:

There is no superposition state in the basic unit of a classic computer (classic bit), and the classic bit can only be "0" or "1". The basic unit (qubit) of a quantum computer is a quantum superposition state, which is a basic unit of a quantum superposition state with both "0" and "1", that is, a qubit can contain both "0" and "1" information. By operating on the superimposed qubits, the operations on "0" and "1" can be completed at the same time. In this way, as the number of qubits in quantum computers increases, the information that quantum computers can process will increase exponentially.

Summarizing the above-mentioned engineering descriptions and theoretical expressions, we can see that whether a quantum computer can be realized, the most critical point is whether a qualified and stable quantum basic unit can be constructed. Furthermore, it is whether a quantum processor that maintains a stable superposition state can be manufactured. In this way, the quantum superposition state has become a key factor in determining the success of a quantum computer.

Therefore, the engineering macro-problem of manufacturing quantum computers has been transformed into a micro-problem based on the basic theory of quantum mechanics.

VI. BASIC THEORETICAL ISSUES OF QUANTUM SUPERPOSITION STATE

According to the above discussion, the manufacturing problem of quantum computers has changed from an engineering problem to a basic theoretical problem and from a macro problem to a micro problem.

Now, before constructing a quantum computer, we must answer the most basic question, that is, whether the superposition state of quantum really exists. If it exists, it means that no matter how long it takes, humans will be able to build quantum computers. Even if the first prototype quantum computer is so rough and the calculation process and results are so unstable, we believe that through continuous improvement, we will be able to create a quantum computer that satisfies human beings. However, if the quantum superposition state does not exist, then the quantum computer will become the second perpetual motion machine and will never succeed.

In order to deeply understand the superposition state of qubits, one must return to the most basic theory of quantum mechanics to understand its ins and outs.

As mentioned earlier, the concept of quantum computers is based on the Copenhagen School's interpretation of quantum mechanics. This explanation is mainly put forward and summarized by Bohr, Heisenberg and Born. The Copenhagen interpretation contains at least the following important points.

1. The quantum superposition state of a quantum system can be expressed by the wave function in the Schrodinger equation. The description of the wave function is a probabilistic function.
2. The position and momentum of a particle cannot be determined at the same time.
3. Matter has wave-particle duality.
5. An experiment can show the particle behaviour or wave behaviour of matter; but it cannot show both behaviours at the same time. This is the principle of complimentarily.

Because there is not enough experimental support, and the content of its theory is puzzling, especially some inferences derived from its theory are even more suspicious. Therefore, many quantum physicists are full of doubts and doubts about the Copenhagen School. Distrust. There are many outstanding figures among these characters. These outstanding figures are represented by some famous scientists such as Einstein, Schrodinger, and De Broglie. For example, Schrödinger proposed the Schrödinger equation, but he himself firmly opposed the Copenhagen School's probabilistic interpretation of his equation.

Although some mathematicians helped Copenhagen explain to establish a relatively rigorous system in the mathematical sense, due to the lack of sufficient physical experiment support, this so-called rigorous mathematical system does not represent a perfect physical explanation.

In fact, one of the truly controversial aspects of the Copenhagen School's explanation is the existence of quantum superposition states.

Here are two examples to illustrate whether the quantum superposition state exists or not.

Example 1

Many readers know that in the history of quantum mechanics, Schrödinger tried to use a cat to illustrate the uncertainty of the quantum superposition state in the Copenhagen interpretation.

Schrödinger's Cat (Schrödinger's Cat) is a thought experiment about quantum superposition states in the microscopic world. Although there have been many popular science articles on this experiment, the author recommends that interested readers read it and make their own judgments.

In this thought experiment, according to Copenhagen's explanation, the cat in the container is in a "dead-alive" superposition state. In other words, this cat is both dead and alive! You have to wait until you open the container and take a look at the cat to determine its life or death. Please note that it is not a discovery but a decision. You don't need any weapons to kill this cat, just a glance is enough to kill.

This thought experiment turned the microscopic superposition state into a macroscopic uncertainty. The superposition of this cat, both alive and dead, violates objective laws, logical thinking, and the feelings of human daily life. Therefore, Schrödinger used this thought experiment to show that there is no quantum superposition state in the microcosm. Historically, this thought experiment was endorsed by Einstein.

Logically speaking, if you accept Schrödinger's cat experiment, then it is admitted that the quantum superposition state in the Copenhagen school does not exist. If we accept Copenhagen's explanation, we will admit that there is at least one dead and alive cat in our daily lives. This completely violates the observation conclusion of our daily life.

The founders and supporters of the Copenhagen School have argued that the micro world is different from the macro world. So here comes the problem. If we say that the micro world and the macro world are different, humans should have two different basic principles of logical thinking: one is the logical thinking principle of the micro world, and the other is the logical thinking principle of the macro world. However, another question arises: What is the standard for distinguishing the micro-world from the macro-world? Is the standard of this distinction microscopic or macroscopic? Is it a superposition state that is both microscopic and macroscopic?

Although some experiments claim to have made Schrödinger's cat, a quantum superposition state has been produced. However, when you read these papers carefully, you will find that these experiments have loopholes or are not rigorous, because the existence of superposition requires two states to exist at the same time, without the problem of time interval.

Example 2

In June 2019, several scientists studying quantum mechanics published a paper in June 2019. The Chinese media call it the Yale University experiment. They reported on the experiments they conducted. The paper was first published in the online edition of the journal Nature on June 3, 2019. Later, this new research was published in Physical Review Research on September 29, 2020. Please see Reference (2).

Although there are different understandings and interpretations of the results of this experiment, the results of the experiment severely shaken one of the fundamental dogmas of the Copenhagen School, that is, the probabilistic nature of quantum behaviour, and supports the theories of Einstein and Schrödinger to a certain extent. The board supported Einstein's clear statement "God does not roll the dice".

In this experiment, the researchers revealed the subtle behaviour of quantum transitions for the first time, showing that in a quantum system, part of the behaviour is predictable, not entirely random. Interested readers can directly read the original text of the paper, see reference article 2).

This result is contradictory to the Copenhagen School's interpretation, because the Copenhagen School believes that the behaviour of quantum systems is completely random and unpredictable. It's like the Copenhagen School said that a piece of paper is all white, not black. However, this experiment showed that the paper is not all white, and part of it is black.

In addition, it takes time for quantum to transition from one state to another, and the two experimental states cannot exist at the same time. In other words, at least in this experiment, the superposition state of quantum has not been discovered.

VII. CONCLUSIONS

a. This article considers the manufacturing of quantum computers from the perspective of engineering and basic theory. By discussing the basic units of quantum computers, a macro-engineering problem (the engineering manufacturing problem of quantum computers) is transformed into a basic theoretical micro-problem (the problem of superposition states of quantum systems). Through analysis, it is believed that the quantum computer currently conceived by mankind, that is, the quantum computer based on the superposition state of the Copenhagen school of quantum mechanics, cannot be built. This kind of quantum computer will be the second in human history "perpetual motion machine."

b. Now in the process of manufacturing quantum computers, we have encountered serious quantum instability problems. Why is there such a problem? The reason is actually very simple. Because there is no superposition state at all in the microscopic world, engineering has encountered a problem of instability in the basic unit (qubit) of a quantum computer, that is, quantum correlation. Just imagine, if the superposition state exists, will its stability be a serious problem? It is precisely because it does not exist that there is a problem of stability.

c. Although the manufacture of quantum computers is an engineering problem, it is also an experiment. This experiment is a huge, unprecedented experiment and test of the Copenhagen theory, that is, whether the manufacturing of quantum computers can be realized under the guidance of the theory of this school. If it fails in the end, then this is just a failure of the Copenhagen School, but it is by no means a failure of the great discipline of quantum mechanics, because the Copenhagen School is only a school of quantum mechanics. It will be a victory for science and proves once again that scientific progress must be based on experiments.

d. Classical computers are based on the existence of the basic unit "0" or "1", and quantum computers are based on the simultaneous existence of the basic unit "0" and "1". This "or" and "simultaneous" is the only standard that distinguishes a classical computer from a quantum computer. If the "0" and "1" states in the basic unit of a quantum computer cannot exist at the same time, then it will still be a classical computer.

e. We should strictly distinguish between quantum mechanics theory and Copenhagen school theory. The rationalism of the Copenhagen School is only a part of the idealism in the discipline of quantum mechanics, not the whole of it.

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