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Abstract

Are financial markets predictable? How to predict the financial markets? These important questions are not answerable in the existing framework of either finance or economics. This paper shows in details that these questions are also not answerable in the existing framework of modern physics. In order to answer these important questions, this papers shows that one must develop a new interpretation of quantum mechanics which makes social science to be a branch of quantum physics like optics and chemistry. By critically examining the question how to predict the human behavior using Newtonian physics, special relativity, general relativity, thermodynamics, and QM with the Copenhagen interpretation, this paper reaches a stunning conclusion that the existing laws in all branches of physics can neither explain nor forecast the human behavior. This is the intolerable human behavior paradox facing physicists today: on one hand, the modern physics can explain and forecast the behavior of physical systems ranging from the tiniest elementary particles to the largest structures of the visible universe with amazing accuracy; on the other hand, ironically the existing physics cannot explain nor forecast the human behavior in our everyday life. The most important contribution of this paper is to prove that it is much easier to solve the measurement problem in QM, the human paradox, and many unanswerable questions in social science together than to solve them individually. This paper proposes a new interpretation, called JJW interpretation of QM, to replace the flawed Copenhagen interpretation and solve the measurement problem, human paradox, and many unanswerable questions in social science. The central points of JJW interpretation of QM is condensed into five new fundamental laws of physics, which are called physics laws of social science (PLSS). PLSS turns out to be a very powerful tool for social science because it reformulates every single problem in economics, politics, and other branches of social science into a physics problem. PLSS solves many outstanding fundamental questions in social science: how humanity should govern itself, whether the future can be forecasted, and how to predict the future. In economics, a fundamental equation of economics can be derived from PLSS. The fundamental equation of economics invalidates many popular economic theories and models, and concludes that the existing economics is not really a science without an extensive house cleaning. In political science, PLSS leads a conclusion that US constitution has many fundamental design flaws, and the permanent world peace is theoretically and practically feasible. Based on the extensive empirical evidence of human behavior supporting PLSS and the profound logical consequence of PLSS, this paper concludes that JJW interpretation is probably the correct interpretation of QM. This paper also shows that JJW interpretation of quantum mechanics is experimentally testable.

1. Introduction

The interpretation of quantum mechanics is one of most elusive and intractable problems at the foundation of the modern science. The problem has been outstanding since the day the quantum mechanics was born. Many professional physicists question whether the correct interpretation of quantum mechanics is a truly relevant scientific question that could lead to new physics and new technologies. Many different interpretations of quantum mechanics have been proposed over years [1-5]. Yet there is no agreement about which is the correct interpretation. Despite its all weakness, the most widely accepted version among professional physicists is still the old Copenhagen interpretation of quantum mechanics.

What is the interpretation of quantum mechanics? The interpretation of quantum is to provide answers to many questions about the nature of the physical world, the quantum mechanics, and the relationship between physical world and quantum mechanics. Here is a list of usually asked questions on an interpretation of quantum mechanics:

1. Is the world deterministic or indeterministic?
2. What is predictable and what is not predictable about the physical world by quantum mechanics?
3. What is the nature of reality?
4. What is the nature of the wave function?
5. What is the nature of the measurement?
6. What is the role of the observer in a measurement?
7. Does the wave function collapse? Why and how does it happen?
8. Is quantum mechanics local or non-local?
9. What is the information?
10. Is there a connection between the wave function collapse and the arrow of time phenomena?

This paper takes a different approach to build a new interpretation of quantum mechanics. Instead of focusing on the usual metaphysics arguments, we focus on something we are intimately familiars with in our daily life: the human choices. We make hundreds and thousands choices every day from choosing food to eat, roads to drive, clothes to wear, and words to say.

The human choices are so important to our humanity that most books in the Library of Congress are about human choices. History is about choices made in history; economics is about economic choices; politics is about political choices; sociology is about social choices; law is about legal choices; fictions is the choices of words descripting the choices by fictional figures; medicine is about choices of medications; football games is about choices of coaches and players; music is about choices made by composers and performers; and painting is about choices made by painters.

Despite its importance, we do not have a coherent physics theory about the human choices. As a matter of facts, there is no “choice” concept in the modern physics. The human behavior paradox says that the human behavior is incompatible with the existing framework of physics. The following is a list of questions about the human choices, human behavior, and human society.

1. Is the human behavior deterministic or indeterministic?

2. What is predictable and what is not predictable in the human society?

3. What is the nature of historic, present, and future reality? Can people create their own future reality?

4. What is the nature of the future uncertainties?

5. What is the difference between the human perception and reality?

6. What is the role of human observers in a quantum mechanics measurement?

7. What is the nature of human free will? What is the nature of the human choices?

8. What is the difference between human choice and the wave function collapse?

9. What is the information?

10. Is there a connection between the human choices and the arrow of time phenomena in human society?

It is very surprising to see that the list of question about human choices is almost the same as the list of questions about the interpretation of quantum mechanics. As it turns out, this is not accidental.

A key contribution of this paper is to show that to build the coherent physics of human choices is equivalent to build a new interpretation of quantum mechanics. The reason is simply that human free will and human choices are fundamentally quantum phenomena. If all human behavior can be described by quantum mechanics including the experimental quantum measurement processes, the famous measurement problem in quantum mechanics would vanish completely.

Physics Theory of Human Choices = A New Interpretation of Quantum Mechanics

Because we concentrate on something as familiar as the human choices, the previously elusive and difficult task of building a new interpretation of quantum mechanics is simple and straight forward. And the new interpretation, which we call the JJW interpretation of quantum mechanics, has profound implications on almost every corner of the human knowledge because the new interpretation essentially provides a fresh new quantum mechanics perspective to look at human choices in every book in the Library of Congress.

This paper is structured in the following way. We first highlight the human behavior paradox to show that the existing framework of modern physics must to be modified in order to build a physics theory of human choices. We discuss the measurement problem in quantum mechanics. Then we shift to unanswered questions in social sciences. We discuss the importance of combining the human behavior paradox, the measurement problem of quantum mechanics, and unanswerable questions in social science together. Then we present the JJW interpretation of quantum mechanics. The first application is to answer many open questions. Then we show the JJW interpretation provides answers to 10 outstanding unsolved problems in physics. We provide brief answers to many previous unanswerable important questions in social science.

2. Human Behavior Paradox

In this section, we prove that the observation of the human behavior cannot be explained nor predicted by the existing laws of all branches of physics.

We critically examines the question how to predict the human behavior using Newtonian physics, special relativity, general relativity, thermodynamics, and QM with Copenhagen interpretation, this paper reaches a stunning conclusion that the existing physics laws can neither explain nor forecast the human behavior.

This is the intolerable human behavior paradox facing physicists today: on one hand, the modern physics can explain and forecast the behavior of physical systems ranging from the tiniest elementary particles to the largest structures of the visible universe with amazing accuracy; on the other hand, ironically the existing physics cannot explain nor forecast the human behavior that physicists live and observe in our everyday life.

2.1 Limitations of Classical Newtonian Physics

Consider to build a forecasting model of movements of a three years old kid in a well-defined environment of the physics laboratory using the classical Newtonian physics.

The central question is to forecast where the three-years-old kid will be in 5 minutes under a well-defined setting. According to the modern physics, the familiar macroscopic world of everyday life should be ruled by the classical Newtonian physics. While we do know that the movement of a rock is precisely described by the classical Newtonian physics, physicists have no idea how to predict kids' movements in next 5 minutes using the Newtonian laws of motion.

The sharp distinction between an animated object like a person and an unanimated object like a rock was first described by the ancient Greeks. In his book "Physics", the Greek philosopher Aristotle noticed a general rule of motion: an animated object like a human or a sheep moves by itself; while an unanimated object like a rock or a table needs be pushed in order to move. According to Bertrand Russell [6], the Greek's view on motions fits naturally with their worldviews that the Sun is dragged by Apollo in his chariot. Aristotelian physics was the mainstream paradigm in Europe until 2000 years later of the time of Galileo and Newton.

Issac Newton developed his laws of motions by rejecting the Greek central idea of motion that an unanimated objects needs to be pushed in order to move. Newton's first law says that an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

In last 327 years since the publication of Newton's "Principia", the Newtonian physics has achieved so much success that most physicists if not all have completely forgotten that Newtonian physics does not work for animated objects, and the sharp distinction between an animated object and unanimated object described by Aristotle.

Based on the fact that the classical Newtonian physics has completely failed to predict the future motion of a three-years-old kid, this paper asserts that an animated object does not obey the Newtonian's law of motion, or any other branches of physics in current form.

This paper does not assert that the Newtonian physics is completely wrong. Any professional physicist knows that the validity of the Newtonian physics is well beyond the reasonable doubt. As a matter of a fact, the foundation of the sports medicine [7] is exactly the Newtonian physics.

This paper only asserts that the classical Newtonian physics have been very successful describing the behavior of unanimated objects and have failed so far in predicting the motions of animated objects including the human behavior.

In the age of searching for the theory of everything, the failure to predict human behavior is intolerable and implies a very serious problem in the existing framework of the modern physics. Because physicists are very confident about everything happening in a physics lab, and physics theories can explain and forecast the behavior of physical systems ranging from the tiniest elementary particles to the largest structures of the visible universe with amazing accuracy, it is ridiculous that physicists can neither explain nor forecast the simple human behavior in a physics lab.

2.2 Limitations of Special Relativity

Einstein's 4-dimensional spacetime is a mathematical model that combines the 3-dimensional space with 1-dimensional time into a single interwoven continuous physical object. The 4-dimensional spacetime concept is at the very foundation of special relativity and general relativity theory, and is one of the cornerstones of the modern physics.

However, when applying the 4-dimensional spacetime concept to describe the human behavior, it reveals that Einstein's 4-dimensional spacetime concept is deeply flawed.

(1) In our everyday life, the time is very different from the 3-D space. The human being can go left and right, forward and backward, and up and down freely. But we cannot go into the past or into the future freely.

(2) In our everyday life, the time is going only one direction: forward. The time never goes backward like the rewind of video type. The 3-D space does not have a preferred direction.

(3) The most disturbing is the fact that the objective future and past cannot exist, while the existence of the 3-D space is self-evident. For example, you could choose to be in either New York City or Boston tomorrow. The fact that you can choose your own future must mean that the objective future cannot exist because you can create your own future. If the object future does not exist, the objective past cannot exit either. What we know about the past only exists in our memory or in the today's material records. There is no living George Washington in anywhere in the Universe. What we know about the first president of United States only exists in his estate in Mount Vernon, today's books, pictures, movies, and in our memory. For famous biblical figures like Adam, Eve, Noah, Abraham, and Moses, we don't even know for sure whether they really existed in the past.

In the daily world around us certainly does not fit neatly with the Einstein's 4-D spacetime description. Of course, for any professional physicist, the validity and

usefulness of Einstein's 4-D spacetime description is well beyond reasonable doubt. It is an interesting paradox.

2.3 Limitation of General Relativity

Consider to build a forecasting model of movement a spaceship circling the moon using the gravity theory like Newtonian physics or general relativity.

The central question is how to forecast how the spaceship is going to move around the moon. According to the modern physics, the motion of the spaceship should be completely described by Einstein's general relativity theory. In theory, the general relativity is the precise description of the motions of any object in the gravity.

If the spaceship does not fire any rocket, the general relativity gives very accurate predictions of the future movement of the spaceship. However, if the spaceship is driven by an astronaut, who can fire the rockets as he wishes, suddenly the predictability of the future motion completely disappears. The future motions depend on predicting when and how the astronaut is going to fire the rocket, which is well beyond the ability of the general relativity.

The fact, that the general relativity could not even remotely provide any idea how to predict the behavior of the astronaut and the spaceship, proves that the general relativity is incomplete in the sense that not all gravity-related physics phenomena could be described by the general relativity equations. Put it in a different way. Although you could solve the Einstein spacetime equation for a spaceship, your prediction sometimes matches the observed spaceship movement, and sometimes do not match.

The 4-dimsional spacetime is the basic language used by the general relativity theory. The central assumption of the general relativity is the existence of the objective and deterministic future. However, in general cases, the objective future does not exist. If there is no objective future, the prediction of general relativity will be wrong. Because the time is not the same as space, the foundation of the mighty general relativity looks very shaky.

It is important to point out the incompleteness of the general relativity because the general relativity is considered as one of the key building blocks to build the theory of everything by many physicists. The incompleteness of the general relativity means that the general relativity cannot be the last words of physics.

2.4 Limitations of Thermodynamics

Consider to build a thermodynamic model for an isolated toy room with a teenage inside. If the teenage completely messes up the room, it is easy to apply the second law of thermodynamics to explain that entropy or the disorder always increase in an isolated environment.

However, under the same condition, the teenage is also capable to organize the messy room into a very nice order, or anything in between like a half room order and the other half disorder. It becomes very challenging for the second laws of thermodynamics to explain all these possibilities, and to define the concept of entropy for the human behavior and the human society.

In the history of thermodynamics, many earlier physicists marveled at animated objects' ability to defy the second law of thermodynamics with ease. Lord Kelvin once wrote: "The animal the animal body does not act as a thermo-dynamic engine; and very probable that the chemical forces produce the external mechanical effects through electrical means. Certainty regarding the means in the animal body by which external mechanical effects are produced from chemical forces acting internally, cannot be arrived at without more experiment and observation than has yet been applied; but the relation of mechanical equivalence, between the work done by the chemical forces, and the final mechanical effects produced, whether solely heat, or partly heat and partly resistance overcome, may be asserted with confidence. Whatever be the nature of these means, consciousness teaches every individual that they are, to some extent, subject to the direction of his will. It appears, therefore, that animated creatures have the power of immediately applying, to certain moving particles of matter within their bodies, forces by which the motions of these particles are directed to produce desired mechanical effects."

In modern physics, the entropic force is one of most powerful forces in the universe because they are everywhere in the universe from the formation of galaxies to the aging of our parents. Yet animals and humans could easily defy such powerful forces. This observation suggests the physics of the human behavior must be very fundamental.

When physicists are talking about the spontaneous irreversible processes, the world "spontaneous" is used to emphasize no human involvement. The reason is simply because the human behavior is not compatible with the second law of thermodynamics.

The thermodynamics also has a serious trouble in explaining the Darwinian evolution in biology. It is easy to explain why a dead man turns into a pile of dusts using the second laws of thermodynamics. However, Darwinian evolution says it is also possible in nature for piles of dust turns into today's 7 billion human being. The second laws of thermodynamics just cannot handle the Darwinian evolution at all.

People have argued that the Darwinian evolution does not contradict with the second laws of thermodynamics because the earth is an open system. However, for professional physicists, it is obvious that none of the existing laws of physics can explain the Darwinian evolution. Without a firm theoretical physics foundation, Darwinian evolution is really more a magic or a summary of empirical observations than a science.

2.5 Limitations of Quantum Mechanics and Measurement Problem

Despite the great success of quantum mechanics, the Copenhagen interpretation, which is the philosophic physics theory interpreting the meaning of quantum mechanics, suffers great difficulties famously known in science as the "measurement problem". Albert Einstein summarized the measurement problem in a simple question, "Does the Moon exist when we're not looking?"

When he put quantum mechanics in a rigorous axiomatic framework, John von Neumann [3] formulated the measurement process in the Copenhagen interpretation of a quantum system in two steps: (1) the quantum system evolves according to the initial conditions and the mathematical formulation of quantum mechanics. The evolution of the wave function of the quantum system is deterministic. (2) A measurement of the quantum system takes place. The measurement causes the wave function of the quantum system to

make a quantum leap to the observed state. The measurement process, or the wave function collapsing process, is indeterministic.

The measurement problem of the Copenhagen interpretation is that the mathematic formulation of quantum mechanics is unable to describe the process of measurement, even though with today's computer technology the measurement process could be completely automated to without people's interference.

There are internal contradictions in the existing framework of quantum mechanics. On one hand, the mathematic formulation of quantum mechanics like Schrödinger equation and quantum field theories appears to describe the dynamics of a quantum system correctly. On the other hand, the experimental observations have been in excellent agreement with the collapsed quantum states. Yet the deterministic mathematic formulation of quantum mechanics and the indeterministic collapse of the wave function by measurement are directly contradictive with each other.

In the following, we are going to criticize the Copenhagen interpretation in a constructive way to lay the foundation of a brand new interpretation of quantum mechanics proposed in this paper.

- When he put the quantum mechanics in a rigorous axiomatic framework, John von Neumann was the first person to notice that the behavior of a quantum system in quantum mechanics is deterministic, and the measurement process is indeterministic. Therefore, quantum mechanics is unable to describe the process of measurement, even though the measurement could be completely automated to minimize people's interference.

- Copenhagen Interpretation is completely silent about the definition of types of measurement that will cause the wave function to collapse.

- If a human being is a special observer of the universe, what about a cat or other living creatures? Biologists tell us that there are no fundamental difference between a human and a cat at the molecular, genetic, and cellular level. After all, the universe has been around for about 15 billion years, since the big bang, and bacteria have been living in the earth for more than 3.7 billion year, whereas the modern human emerged only about 200,000 years ago.

- Copenhagen interpretation provides two self-contradiction conclusions when treating humans as a quantum system. If the mathematical formulation of quantum mechanics can describe the human being as a quantum system, human's behavior will be deterministic. However if the human is used as the measurement tool because human has sophisticated sensors like eyes, human's behavior would be indeterministic. Is human behavior deterministic and indeterministic? Therefore, Copenhagen interpretation could not handle the human behavior in a logic consistent way.

- Copenhagen interpretation fails to provide clear guidance to questions in other fields of physics, like whether Brownian motion fundamentally indeterministic or

deterministic and whether the turbulent flows of simple fluids is fundamentally indeterministic or deterministic.

To summarize, the success of Copenhagen interpretation and quantum mechanics comes from its powerful mathematic formulations, universal experimental supports, and its probabilistic interpretation. The problems of Copenhagen interpretation are the measurement, the interpretation of the wave function as the physical reality, and inability to explain the human behavior and the human's role as the ultimate observer of the universe.

2.6 Summary of Limitations of Modern Physics

If an alien is visiting our solar system, he would be amazed by the sharp difference of landscapes between Mars and the earth. The surface on Mars appears ancient and mechanical. The dynamics of Mars surface could be sufficient accurately described by the classical Newtonian physics. The dynamics of the landscape in places like Manhattan on the earth with buildings and streets is totally different from anything happening on Mars. The sharp difference of the landscape dynamics tells us probably a different set of laws of physics are governing in two places.

In previous sections, we have shown that the physics explanation of the human behavior is challenging for all branches of modern physics from Newtonian physics, special relativity, thermodynamics, general relativity, to quantum mechanics.

The fact that the human being could make a plan and create his or her own future is beyond anything that physicists are used to study. The rocks or electrons do not make their plans to visit different places in the future. But the human beings do that all the time.

Therefore, the human behavior paradox reveals is a critical flaw in the existing framework of modern physics.

3. Unanswerable Questions in Social Science

There are many unanswerable questions in social science. Is social science really a science? American physicist Richard Feynman did not think so because there are no universal laws ever discovered in social science. Feynman famously labeled social science as pseudoscience.

In economics, is economics a science? According to the 2013 economic Nobel Prize winner Robert Shiller [8], economics is far from a science. Then how to make economics a science? Is the recession predicable? If the government could predict a recession is coming, the government could take the fiscal and monetary policy changes to prevent the recession from becoming the realized reality. However, the original prediction would be wrong.

In politics, how should we govern ourselves? For thousands of years, the important question has attracted some greatest thinkers in history including Confucius, Plato, Aristotle, Machiavelli, Locke, Washington, Jefferson, Madison, Kant, Marx, Einstein, Hayek, and many others, yet the problem remains largely unsolved. Is political science really a science? Could a political theory be falsified? The communism

movements in the 20th century have claimed more than 100 million victims around the world [9]. One could only wish that a political theory like communism could be first experimented in a small and limited scale before it was fully implemented in some biggest countries in the world.

In history, is history a science? Only few historians think themselves as scientists. However, cosmology, which studies the history of the universe, is now a red hot physical science. Why should the history of the universe not include the human history?

The opposite of history is the future. For most people, knowing the future is far more valuable than knowing the history. Yet despite its importance, there is almost no formal subject devoted to study the future. In the past thousands of years, astrology has been the parallel subject to history, as a field of human knowledge. However, today, while most universities have history departments, virtually no university would have an astrology department. Would it make more sense to teach kids more about the future than history? A new field called futurology [10] is so young that there are few followers. The main difficulty of studying the future is that we do not know whether the future is predictable and how to predict the future.

In finance, are the financial markets predictable? How to predict the financial markets? If financial analysts could predict AIG corporate bonds were going to default and AIG was going to file bankruptcy in the great recession of 2008, could the analysts also predict that the Federal Reserve was going to loan AIG $85 billions to prevent the company from collapsing?

These are all very fundamental and very difficult questions in social science. However, these questions are unanswerable in the existing framework of social science, because these questions are all related to the physics nature of human behavior, and cannot be solved by the available existing tools in social science.

3.1 Solving Jigsaw Puzzles

Standing alone, the measurement problem in QM, the human behavior paradox in physics, and unanswerable questions in social science are very difficult, intractable, and almost impossible to solve. These questions have been outstanding for years or even thousands of years.

The most important contribution of this paper is to group these problems together, and point out that these problems are closely related with each other. When questions from three completely different sources come together, each question brings their own priceless hard and soft constraints on the possible solutions just like a jigsaw puzzle.

The main difficulty to solve the measurement problem in QM is lack of experimental and logic consequences. There are many physicists don't even think the measurement problem is really a problem for physics. There are many different interpretations of QM already exists [1-4]. Do they actually matter in terms of producing experimentally testable hypothesis, new technological inventions, or producing new insightful physics theories that solve other outstanding problems in other fields of nature and social science?

The human behavior paradox in physics reveals the weakness of the existing framework of modern physics. It also points out that the solution of the human behavior paradox is probably at the deepest foundation of the modern physics.

The unanswerable questions of social science and human behavior paradox in physics bring many priceless constraints on the possible solutions: the right physics of human behavior must allow the flexible and indeterministic future, must allow macroscopic forecasts to be probabilistic, must have simple and clean physics explanations of human choices and human free wills, must allow new information to be created, and must give one coherent answer to all arrow of time phenomena ubiquitous in many fields of social and natural science.

The measurement problem in QM and human behavior paradox in physics bring some hard constraints on the possible solutions: the new physics must be consistent with all established experimental observations in physics and many well-established physics theories.

To satisfy all these constraints, we need a new interpretation of quantum mechanics, which will solve the measurement problem, the human behavior paradox, and unanswerable questions in social science.

The nature of JJW interpretation of QM is that long before we invent the quantum mechanics and learn how to interpret the quantum mechanics correctly, the nature knows QM and the correct interpretation of QM. The mother nature has been taking advantage of the flexibility offered by QM to invent the free wills and enhance the chances of survival by creating your own preferred future. This observation explains why the measurement problem in QM, the human behavior paradox in physics, and unanswerable questions in social science are so closely related. Thus, in essence, the social science interpretation of QM is the mother nature's interpretation of QM.

4 JJW Interpretation of Quantum Mechanics

Quantum mechanics is an unusual science. Although quantum mechanics has been very successful in predicting experimental results, nobody in the world knows exactly what quantum mechanics is telling us about nature. An interpretation of quantum mechanics is an attempt to explain what quantum mechanics is exactly telling us.

An interpretation of quantum mechanics is to provide the explanation of the relationship between physical reality and measurement processes, the role of human beings in formulating laws of physics, and the meaning of the wave function, Heisenberg Uncertainty Principle, Schrodinger Equation, and any other relevant physics concepts. The correct interpretation should solve the measurement problem of quantum mechanics and be consistent with all experimental observations and established theories in physics, chemistry, and all other fields in natural and social science.

In this section, we are going to present the complete description of the new interpretation of quantum mechanics. We call the new interpretation the JJW interpretation of quantum mechanics in order to distinguish it from the Copenhagen and other interpretations.

JJW are my name initials. Just like many other folks, I am also dreaming of being remembered by future generations, although my quantum mechanics theory says historic information is like a love poem written in the sands and will be unavoidably erased by quantum uncertainties in the future.

4.1 Realism

The measurement problem of quantum mechanics is raised from difficulties of separating the physical reality and measurement processes. The JJW interpretation solves the measurement problem by insisting on separating the physical reality and measurement processes. The measurement processes do not play a fundamental role in formulating laws of physics.

The JJW interpretation supports realism. Realism means that an objective physical reality exists independently with or without the human as an observer, and objective physics laws exist independently from any measurement. On the other side of the opinion, some people believe everything in the world is a matter of perception.

From Copernicus's theory of a sun-centered solar system to the recent decoding of human genomic codes, most scientists have concluded that the human is not the center of the universe and the human is just another living creature. In contrast to Copenhagen interpretation, which claims that humans are special observers of the universe, the JJW interpretation supports the idea that the human is another ordinary complicated quantum system and quantum mechanics is essential and sufficient to describe human behavior.

Einstein once asked: "Does the moon really exist if nobody is watching it?" The answer from The JJW interpretation is yes. The moon does exist without people watching. Einstein's view of the realism is right after all.

4.2 Law of Indeterminacy

Einstein would be very happy to see the restoration of his view of realism in physics. He, however, would not be so pleased to see that God does play dice. Actually, God plays dice with everything in this world. The behavior of all elementary particles is indeterministic. Every future event in the world is indeterministic. Of course, there are certain events in the world that could have only one possible outcome according to the fundamental laws of physics.

Here is the **Law of Indeterminacy**:

> For a closed system, the outcome of any future event is indeterministic. The quantum uncertainty of the future is the fundamental property of the nature and cannot be overcome by any means.

The behavior of the photon in the single slit experiment is indeterministic. The random behavior of the photon is the fundamental property of the nature. Nothing can be done to predict the photon location on the observation screen more precisely than the probability distribution given by the quantum mechanics.

For example, the radioactive decay of an atom is indeterministic. The randomness of the decay time is the fundamental property of the nature. Nothing can be done to predict the decay time more precisely than the probability distribution given by the quantum mechanics.

4.3 Macroscopic Quantum Phenomena

One of single biggest misconceptions of modern physics is to believe that quantum phenomenon is only limited to the microscopic atomic world. The central idea

of this paper is that microscopic indeterministic behavior of elementary particles can be amplified into macroscopic quantum uncertainties. In this section, we will show that one of amplification mechanism is the collision of atoms and molecules.

For example, the radioactive decay of an atom is indeterministic. Radiation from a single atom is sufficient to break DNA molecules to cause cancers in people. Indeed a recent report from National Academies' National Research Council says that even low doses of radiation like X-rays are likely to pose some risk of adverse health effects. No threshold of exposure below which low levels of ionizing radiation can be demonstrated to be harmless or beneficial. Put it simply, the true safety threshold is zero.

The most striking aspect of the single slit single photon experiment is that the indeterministic behavior at the microscopic scale of the optical wavelength is amplified into a macroscopic phenomenon easily observable on the screen. The amplification mechanism is the collision between the photon and atoms of the slit. According to the new version of Heisenberg uncertainty principle, because the photo and atoms **cannot possess** the precise positions and precise momentums at the same time, the outcome of the collision is indeterministic.

Because collisions between atoms and molecules are the most important processes in physics, the indeterministic outcomes of collisions between atoms and molecules have profound implications for all natural science and social science. It means that the behavior of any macroscopic multi-particle system including human being must be indeterministic.

Consider the superposition of two wave functions ψ_1 and ψ_2:

$$|\psi_1 + \psi_2|^2 = |\psi_1|^2 + |\psi_2|^2 + (\psi_1 \psi_2^* + \psi_1^* \psi_2).$$

Although every physicist knows that the term $(\psi_1 \psi_2^* + \psi_1^* \psi_2)$ could produce macroscopic quantum phenomena, few physicists know that $|\psi_1|^2 + |\psi_2|^2$ could also lead to macroscopic quantum phenomena because the microscopic indeterminacy can be easily magnified into macroscopic quantum phenomena.

Anyone playing the game of pool will notice that the outcome of the collision is extremely sensitive to the positions and the momentums of two balls just before they collide. Tiny changes of positions and momentums can make huge difference in the outcome. In the microscopic atomic world, the new Heisenberg uncertainty principle says that the photon and electrons **cannot possess** the precise positions and precise momentums at the same time. Therefore, the outcome of the collisions between atoms and molecules must be indeterministic. Because the outcome of the collisions is felt at a much larger scale than the sizes or the DeBroglie wavelengths of atoms and molecules involved in collision, the indeterministic behavior is amplified into much larger scale. For example, in the single slit single photon experiment, the indeterministic behavior of photon is amplified from the wavelength of the photon into centimeters or even meters. We reach one of most important conclusions of this paper: the microscopic indeterministic behavior of atoms and molecules can be amplified into the macroscopic length scale through collision processes.

The atomic collision process explains endless phenomena in physics, chemistry, and biology. Indeterministic atomic collision means we have to revise physics, chemistry and biology extensively. Some of macroscopic quantum phenomena are listed in the following:

1. Brownian motion is fundamentally indeterministic. Indeterministic Brownian motion is really a macroscopic quantum phenomenon.
2. The chaotic and indeterministic turbulent flow is a macroscopic quantum phenomenon. No wonder for hundreds of years no physicist is able to solve the turbulent flow problem using the classical physics.
3. Since turbulent flow is intimately related to weather and solar winds, indeterministic weather and solar winds are macroscopic quantum phenomena.
4. Thermal fluctuations are closely related to atomic and molecular collisions. Thermal fluctuations are macroscopic quantum phenomena. Since thermal fluctuations are present in any system with a temperature, macroscopic quantum phenomena are universal.
5. Biologists found that the replication, transcriptions, and translations of genetic codes are indeterministic and error-prone at the molecular level. Those errors are responsible for many biological processes such as genetic mutation, evolution, aging, and cancers. Indeterministic outcome of biochemical reactions cause many related macroscopic quantum phenomena like sickness and death in living creatures.
6. The most remarkable thing is that living creatures have figured out and actively take advantage of the microscopic indeterministic phenomena billions of years ago. E. Coli bacteria take advantage of microscopic indeterministic atomic configurations to make the bacteria' movements indeterministic.
7. Free will of living creatures is macroscopic quantum phenomena. Indeterministic human behavior is macroscopic quantum phenomena. That is why we cannot predict the world financial markets precisely.

In conclusion, macroscopic quantum phenomena are widespread because the indeterministic behavior of elementary particles. It is a spectacular failure of modern physics to believe incorrectly that quantum phenomenon is only limited to the microscopic atomic world.

4.4 Two Types of Uncertainties

The cause of uncertainty is incomplete information of knowledge. There are two types of uncertainties: uncertainty of the incomplete knowledge of unknowable due to quantum mechanics, and uncertainty of the incomplete knowledge of knowable. In this paper, an uncertainty of the incomplete knowledge of unknowable due to quantum mechanics is called a quantum uncertainty, while an uncertainty of the incomplete knowledge of knowable is called a non-quantum uncertainty. Quantum uncertainty is a fundamental property of the nature and cannot be overcome by any means. Non-quantum uncertainty is simply due to lack of knowledge and can be overcome by people.

For example, the precise decay time of a radioactive atom is quantum uncertainty. There is no way to overcome the uncertainty of the decay time. The future moves in the game of rock-paper-scissors are quantum uncertainties. People's free wills are quantum uncertainties because the final decisions are ultimately up to us. Nobody can predict precisely how people are going to make decisions. The weather in the future is quantum uncertainty.

The hiding place of Osama Bin Laden was non-quantum uncertainty. There are ways to overcome this type of uncertainty. There were people who know where to find Osama Bin Laden. Whether there is life on Mars is non-quantum uncertainty. Eventually scientists will find out whether there is any living creature on Mars. Even though we do not know the answer right now, we know the answer is unique and deterministic in nature.

All uncertainties about the future events must be quantum uncertainties. The Law of Indeterminacy states that uncertainties of outcomes of future events must be quantum uncertainties. The outcome of a sports game and the future occurrence of an earthquake are examples of future quantum uncertainties. Even the timing of a future sunrise is a quantum uncertainty although the uncertainty is small.

Many uncertainties about the present universe are non-quantum uncertainties. The outcome of a sports game just completed is a non-quantum uncertainty because some people know the outcome and the outcome is not indeterministic. However, in the microscopic world of atoms, the new Heisenberg Uncertainty Principle says that elementary particles cannot possess the precise position and precise momentum at the same time. Therefore, there are quantum uncertainties because of incomplete knowledge about the present universe at the microscopic level of atoms.

Many uncertainties about the history of the universe are non-quantum uncertainties because outcomes of historic events were recorded in people's brain or other records. However, the Law of Information in the next section says that historic information is always incomplete and some historic information is lost permanently at any moment. Therefore, many uncertainties about history are quantum uncertainties.

4.5 Law of Information

While the concept of information is central to many fields, only quantum mechanics is able to give a precise definition of information. Information of a close system is the current knowledge of wave functions of elementary particles in the system and equations of quantum mechanics governing the wave functions of particles.

Here is the **Law of Information**:

> The complete historic information of any closed system cannot be recreated based on today's complete information. At any time step, some historic information is lost permanently while new information is being created.

The Law of Information is based on the indeterministic behavior of the elementary particles. According to the Law of Indeterminacy, we cannot predict the future precisely. According to the Law of Information, we cannot recreate the history precisely either. The remote history of each elementary particle becomes more vague at each time step. The Law of Information is fundamental for studies in human and natural history because it shows there are limitations of the historic truth. The Law of Information is fundamental for many fields in social and natural science because it shows that old information is constantly destroyed and new information is constantly created by the indeterministic behavior of elementary particles. The Law of Information is also

fundamental for the criminal laws and the justice system because there are fundamental uncertainties, which cannot be overcome by any means, about past events.

4.6 JJW Demon

Because Newtonian physics is deterministic, French scientist Laplace declared that if he could have the complete information about the universe at a moment, using Newtonian physics, he would have the complete knowledge of all the future as well as all the history of the universe. The Laplace Demon is an imaginary creature who has the complete knowledge of the past, present, and future universe down to every detail.

The JJW interpretation of quantum mechanics is indeterministic. The JJW demon is an imaginary figure who knows wave functions of all elementary particles and equations of quantum mechanics governing wave functions in the present universe.

The JJW demon has the following properties:

1. It has the maximum possible knowledge allowed by laws of physics of the present universe, which is the definition of the complete information in this paper.
2. It can overcome all non-quantum uncertainties.
3. It obeys quantum mechanics and cannot overcome quantum uncertainties.
4. It defines the maximum possible knowledge about history.
5. It defines the maximum possible knowledge about the present universe.
6. It defines the maximum predictabilities about the future.
7. It knows all physics equations and solutions to all physics equations.
8. Compared to Laplace Demon, it has only limited knowledge of the past, present, future of the universe because the limitation imposed by quantum mechanics.

JJW demon is very different from Laplace demon. Laplace demon has the complete knowledge of the past, present, and future universe down to every detail. Laplace demon does not obey quantum mechanics. Quantum uncertainty and JJW demon are two most important concepts in this paper.

4.7 One Universe, One History, and Multiple Future Paths

The behavior of a photon is indeterministic; the behavior of a radioactive atom is indeterministic; the behavior of all elemental particles in the world is indeterministic; the Brownian motion is indeterministic; the human behavior is indeterministic; and the future of the world is indeterministic.

The evolution of the world can be viewed as if the world follows some paths. In the next infinitesimal time step, the world could take one of endless possible paths allowed by fundamental laws of physics. Each possible path corresponds to one different version of the world. At the present, there is only one world. In the past, there is only one path. In the future, the world can take any of endless possible paths. While there is only one universe, there are endless other possible universes which are similar to our universe. While the JJW interpretation allows multiple universes, only our universe is real and all other universes are just imaginary.

For example, the universe with George Washington is different from the universe without George Washington. If the parents of George Washington had decided not to give birth to him, according to the JJW interpretation, the world would have followed a completely different path.

The JJW interpretation is consistent with Feynman integration of all possible history paths approach. When we make forecast in quantum mechanics, we have no choice but to consider all future possible paths.

4.8 Law of Equilibrium

In The JJW interpretation, the time symmetry between the history and the future is broken in a subtle way. The movement of any indeterministic elementary particle is not time reversible and is not symmetric in time. For example, the random walk of Brownian motion is not reversible.

One looks back to the history, the universe takes only one path. When one looks forward to the future, the universe could take many possible paths. If we reverse the direction of time, our present universe will not follow the historic path exactly because of the indeterministic behavior of all elementary particles in our universe. Therefore, there is a direction of time arrow pointing to the same direction of the Law of Equilibrium, which states that

> For a system under certain constraints, quantum uncertainties in the system will eventually push the system toward an equilibrium state.

Most physicists believe that the physical processes at the microscopic level are symmetric with time, and the microscopic processes are reversible. The JJW interpretation rejects these long held misconceptions in physics. The movements of indeterministic elementary particles are not symmetric in time. For example, the path of photon in the single slit single photon experiment is not time reversible.

The Second Law of Thermodynamics, which states that for a closed and isolated system, the system entropy always increases with time. For example, add salt to a cup of water, and soon the whole cup of water becomes salty. The process is irreversible simultaneously and it defines a definitive direction of time. In The JJW interpretation, the Second Law of Thermodynamics is still perfectly valid. However, the scope of the Second Law of Thermodynamics is limited to indeterministic atoms and molecules, and constraints are limited to the conservation of the energy and the mass, constant temperature, constant volume, or constant pressure.

The JJW interpretation recognizes that the Second Law of Thermodynamics can be further generalized to include any type of quantum uncertainty such as the free will and any type of constraint such as the scarce resources in economy, and the result is the Law of Equilibrium. The Second Law of Thermodynamics is a special case of the Law of Equilibrium applying to systems with indeterministic atoms and molecules.

The foundation of the Law of Equilibrium is the indeterministic behavior of elementary particles and mathematics of probability. This is easy to prove that multiple particles doing the random walk will produce the irreversible process of diffusion.

The Law of Equilibrium can be applied to an individual particle. For example, the random walk of Brownian motion is not reversible, and the equilibrium state is the random walk itself.

The Law of Equilibrium is one of central topics of this paper. Financial markets, economy, political systems, ecological systems in biology, and many other systems are pushed by free wills and other quantum uncertainties toward the equilibrium states. We will discuss different equilibrium states in different chapters of this paper.

4.9 Who Controls the Future of the World

All elementary particles in the world collectively decide which path to take next. The world is like a giant boat in the ocean. Everyone on board is given a steering wheel, and collectively we decide the course of the boat. Each time a person makes a choice, he or she is changing the course of the world slightly. Each time a radioactive atom decays, it is changing the course of the world slightly.

While the future of the world is indeterministic, it is still possible that the universe has only one ultimate fate of big crunch, big rip, or the oscillation. At this stage, it is not clear how The JJW interpretation will affect cosmology.

4.10 Law of Prediction

Here is the **Law of Prediction**:

> The outcome of any future event is indeterministic. Any future event can be and can only be predicted to the extent of a joint probability distribution among all possible outcomes. The joint probability distribution function (JPDF) exists and is uniquely given by the quantum mechanics.

The law of prediction is the generalized statement of the Born statistical interpretation. Born statistical interpretation has withstood the test of time and has been the corner stone of the quantum mechanics. The law of prediction is the corner stone of describing the behavior of macroscopic indeterministic system.

For an indeterministic system, the law of prediction plays the role of the formula F=MA in Newtonian physics. The law of prediction describes the causality relationship between the dynamics of a system and the outcome. We will discuss how to build the universal mathematical tools to predict the future in later chapters.

4.11 Law of Choice

Here is the **Law of Choice**:

> Actions, which are constrained by fundamental laws of physics, can be taken between time 0 and time T to modify the joint probability distribution function of time T.

In the JJW interpretation, choice is a very fundamental physics process that cannot be reduced further. When a quantum uncertainty makes a choice, it creates new information and changes the course of the world slightly. This is the nature of choice. For example, when a person makes a choice, he or she is creating new information and changing the course of the world slightly. When a radioactive atom makes a choice to decay, it is creating new information and changing the course of the world slightly. A person makes a choice with a purpose while the radioactive atom makes a choice without any purpose.

Only a future quantum uncertainty can make a choice, and only in an indeterministic world, people are allowed to make choices. For example, a deterministic robot cannot make a choice.

The Law of Choice goes beyond the scope of traditional physics and is especially important for living creatures that have free wills. The law says that living creatures can actively influence their environment and the course of the world. It is important to realize that only in an indeterministic world can a creature with a free will change the future course of the world.

The Law of Choice provides the quantum mechanics foundation for the Rational Choice Theory. While quantum mechanics is indifferent to any choices allowed by laws of physics, some choices are inevitably more desirable than others for living creatures. How to make the best choice is the heart and soul of social science.

4.12 Indeterministic Wave-Particle Duality

The traditional quantum mechanics describes the behavior of elementary particle using the wave-particle duality, which means that an elementary particle behaves like a classical wave and a classical particle at the same time.

The JJW interpretation enriches the picture of the wave-particle duality by adding indeterminacy. **Indeterministic wave-particle duality** means that an elementary particle behaves like a wave and a particle at the same time, the wave is a probability wave, and the particle is an indeterministic particle.

4.13 Wave Function Describe Future Possibilities not Future Reality

The **wave function** is not real; it is simply a device used in the mathematics of quantum mechanics. While the outcome of any future event is described by the joint distribution function, the dynamics of a quantum system is described by quantum mechanics formulation using the wave function. Wave function cannot be observed directly. The behavior of the wave function is governed by theories of quantum mechanics.

Wave function describes future possibilities not future physical reality. According to Heisenberg himself, the atoms or the elementary particles are not real; they form a world of potentialities and possibilities rather than one of things or facts. The wave function is not real; it is simply a device used in the mathematics of quantum theory.

For the sake of visualization, one could regard the wave function as the probability wave. Due to particle-wave duality of an elementary particle, the probability wave has the wave property in classical physics. Countless paradoxes and nonlocality of

the wave function in Copenhagen interpretation are based on the view that wave function is the physical reality.

It is useful to distinguish two different length scales when we talking about the wave function of an elementary particle.

1. The first length scale is the wavelength of DeBroglie material wave, which is the ratio of Planck's Constant and the average momentum of an object. On the scale of the DeBroglie wavelength, the wave function of an elementary particle is a probability wave. And the wave function is coherent and can produce the interference. Many amazing quantum phenomena like superconductors and superfluid are happening at the DeBroglie wavelength scale.

2. The second length scale is much greater than the DeBroglie wavelength, which is the scale of people's everyday life. On this length scale, the wave function of an elementary particle is just the probability wave. The wave function is incoherent and cannot produce the interference. The indeterministic behavior of the elementary particle and the concept of the wave function can be extended into the length scale of people's everyday lives. Therefore, the concept of probability wave can be used to describe the behavior of macroscopic objects such as Schrodinger's cat and world financial markets.

4.14 Quantum Nature of Free Will

Let's first define the free will. Free will of a living creature is the ability of taking both purposeful actions and indeterministic actions. As we will discuss in detail in the section of biology of free will, both purposeful and indeterministic actions are vital for living creatures to find food or mates and to avoid harm.

Free will is a quantum uncertainty. Biologists have not been able to fully understand the physics and biology of the people' brains. However, scientists have worked out the physics and biology of free wills of E. Coli bacteria. Free wills of bacteria, the purposeful and indeterministic movements of bacteria, are the highly amplified and filtered microscopic quantum uncertainties. During billions of years of evolution, living creatures have not only learned to make peace with quantum uncertainties, but also have become masters of manipulating quantum uncertainties. Abilities to manipulating quantum uncertainties are one of most important features of living creatures. We are going to discuss the biology of free wills in detail in next chapter.

4.15 Summary of JJW Interpretation

In previous sections, we have presented the complete description of The JJW interpretation. The central idea of The JJW interpretation is the Law of Indeterminacy. Starting from the Law of Indeterminacy, many different aspects of quantum physics like reality, wave function, information, time symmetry, equilibrium state, predicting the future, choice, and free wills have to be re-examined and formulated.

The backbone of the JJW interpretation is five physics laws of social science. I call them physics laws of social science to emphasis the intimate relationship between social science and quantum physics. While I call them physics laws of social science, five laws are universally applicable to any physical system. However, it is no doubt that the most important contribution of the JJW interpretation is providing a solid theoretical foundation of social science. Here is the summary of physics laws of social science.

First Law – Law of Indeterminacy

> For a closed system, the outcome of any future event is indeterministic. The quantum uncertainty of the future is the fundamental property of nature and cannot be overcome by any means.

Second Law – Law of Prediction

> For a closed system, any future event can be and can only be predicted precisely to the extent of a joint probability distribution among all possible outcomes. The joint probability distribution function exists and is uniquely given by the quantum mechanics.

Third Law – Law of Choice

> Actions, which are constrained by fundamental laws of physics, can be taken between time 0 and time T to modify the joint probability distribution function of time T.

Fourth Law – Law of Information

> The complete historic information of any closed system cannot be recreated based on today's complete information. At any time step, new information is created and some historic information is lost permanently.

Fifth Law – Law of Equilibrium

> For a system under certain constraints, quantum uncertainties in the system will eventually push the system toward an equilibrium state.

Five physics laws of social science are closely related with each other. The Law of Indeterminacy is the starting point. The Law of Predict the Future addresses how to predict the future and the cause and effect relationship of an indeterministic system. The Law of Choice addresses how to make a choice and how a choice will impact an indeterministic system. The Law of Information addresses how information is created and destroyed. The Law of Equilibrium addresses the time symmetry and the equilibrium state. Since these five laws describe the most fundamental behavior of elementary particles, they are qualified as fundamental laws of physics.

5. Questions and Answers about JJW Interpretation

In next few sections, we will apply the JJW interpretation to answer many previously unanswerable questions in social science and physical science. Since many questions are deep and big questions, we have to limit discussions to a few sentences, more extensive discussions can be found in other papers and books. Answering these previously unanswerable questions in social science and physical science using the JJW interpretation is a major contribution of this paper.

5.1 Questions about Predicting the Future

The law of prediction answers questions about predicting the future. The law of prediction says that only joint probability density function (JPDF) of all possible outcomes of an enclosed system is precisely predictable at any moment. The precise outcome is impossible to predict. The impossibility to predict the precise outcome is a fundamental property of the nature and cannot be overcomed by any means. The Law of Predicting Future defines the maximum predictability. Given the complete information, JPDF of all possible outcomes of an enclosed system is precisely predictable using quantum mechanics. Without the complete information, the maximum predictability can only be achieved approximately at best.

Following questions will approach the same question from different perspectives. Analyzing these questions will deepen our understanding of the law of prediction.

Question: Is the future predictable?

Answer: The law of prediction says that the probability of all possible outcomes is predictable. The precise outcome is impossible to predict.

Question: Can traditional astrologists foretell the future?

Answer: No. Astrologists can foretell that the probability of all possible outcomes is predictable. The precise outcome is impossible to predict. Traditional astrologists often use unscientific forecasting methods. There are scientific ways of foretelling the future, and transform the ancient field of astrology into a branch of science dealing with quantum uncertainties in personal life, business, and society.

Question: Why do economists often fail to forecast the economy?

Answer: Economists are trying to forecast things that are impossible to forecast. No wonder they fail so miserably that many employers often wonder any use of economists. Before trying to forecast next year's GDP precisely, I would advise economists to learn from forecasting the precise decay time of a radioactive atom, or from forecasting the future moves of a rock-paper-scissor game. The chapter of quantum economics will discuss how to apply the physics laws of social science to study and model economics.

Question: Can high profile Wall Street financial analysts predict world financial markets?

Answer: No. Financial analysts can forecast the probability of all possible outcomes. The precise outcome is impossible to predict. Therefore, financial analysts should fundamentally change their forecasting methodologies. When they try to forecast precise stock prices, Wall Street analysts are not any better than monkeys. However, if they try to forecast the probability of future stock movements, I have confidence in financial analysts that they should be able to redeem themselves and beat monkeys. Movements of financial markets are not random after all.

Question: Can one predict human behavior?

Answer: One can forecast the probability distribution of all possible behaviors. The precise human behavior is impossible to predict because people have free wills. The chapter of quantum sociology will discuss how to predict human behavior in detail.

In the game of rock-paper-scissors, certain people tend to favor certain moves, or favor repeating the previous move, or favor certain patterns. Given the complete information, quantum mechanics says that the preference in terms of the possibility distribution of the next move is precisely predictable. Therefore, the Law of Predictable Future goes beyond simply stating human behavior is indeterministic, and is capable to provide the rigorous mathematics to describe subtle but important traits of human behavior.

Question: Why is NASA unable to predict precisely when Rover robots to Mars will breakdown?

Answer: Partially it is because of the design. NASA has designed to the Rover robots to run as long as possible. Partially because there are many indeterministic factors influencing the functioning of Rovers. The law of prediction says that NASA can forecast the probability of breakdown for any given time period. The precise time of breakdown is impossible to predict.

Question: Can meteorologists forecast the long-term weather precisely?

Answer: No. There are many indeterministic factors in the atmosphere to prevent meteorologists from forecasting the long-term weather precisely. For example, human influences and turbulent flows are indeterministic. However, the law of prediction says that there is a maximum predictability in weather forecasting.

Question: Can geologist predict the earthquake precisely?

Answer: Collision, friction, turbulent flows of lava, and breakdown of rocks are indeterministic processes. The law of prediction says that the joint probability of earthquake for any given time period is predictable. The precise time of earthquake is impossible to predict. However, the law of prediction says that there is a theoretical maximum predictability in earthquake forecasting. We are going to discuss the earthquake prediction in detail in the chapter of impact on physical sciences.

Question: How can one solve the most important unsolved problem of classical physics, the turbulent flow?

Answer: Turbulent flow cannot be solved in the framework of classical physics. Turbulent flow is really a quantum phenomenon. In quantum physics, the indeterministic turbulent flow is simply a feature of underling indeterministic behavior of elementary particles. While we cannot predict the precise turbulent flow, the law of prediction says that the JPDF of patterns of the turbulent flow is precisely predictable. Since the turbulent flow is relatively easy to study under laboratory conditions, the prediction from law of prediction is testable experimentally.

5.2 Questions About Indeterminism and Fatalism

Question: Who controls our destiny?

Answer: People's free wills, other quantum uncertainties in the society and nature environment collectively control our destiny. There are many types of uncertainties in life, for example, people's free wills, unpredictable animals, earthquakes, financial markets, and accidents. While human cannot overcome quantum uncertainties, human can learn to deal with quantum uncertainties.

Question: Why is fatalism wrong?

Answer: Fatalism is wrong because it denies the existence of free will. Fatalism implies the deterministic outcome and fails to acknowledge that quantum uncertainties are fundamental properties of nature and cannot be overcomed by any means. Decisions made by an individual's free will normally have the biggest impacts on one's life. To some extent, people are controlling their own lives. That is the reason that conventional wisdom teaches us to make our choices wisely.

Question: Why are there so many uncertainties in life?

Answer: People often say that nothing in life is certain. There are many good reasons for that. People have free wills, which are quantum uncertainties. There are many other macroscopic quantum uncertainties such as the weather and earthquakes. Collectively these quantum uncertainties make one's life full of

uncertainties. For example, a young person does not know when to get marry and who to marry.

Question: Is the evolution process in biology deterministic or indeterministic?

Answer: The evolutionary process is indeterministic. However, indeterministic is not the same as completely random. The force of natural selection and the desire of living creatures to survive make certain that the outcomes of the evolution process more likely than other alternatives.

Question: Are we alone in the universe?

Answer: Possible, but very unlikely.

According to the Law of Equilibrium, human intelligence can be proven as the equilibrium states of the evolution of neuron networks. Therefore, the possibility of occurrence of the human intelligence is surprisingly high. We need better understanding of astronomy to estimate the number of livable planets in our universe.

5.3 Questions about Freedom and Choice

Question: Why do people love freedom?

Answer: Because people have free wills. Free wills give people the freedom to think. Free wills give the desire to express their thoughts and to act on their ideas. We are going to discuss the freedom and democratic principles in the chapter of quantum politics.

Question: Do animals have free wills?

Answer: Certainly yes. Just watch how a fish swims, how a bird flies, and how a dog moves. It is easy to conclusion that animals' movements are fundamentally unpredictable.

Question: If animals have free wills, do they deserve some political rights?

Answer: Certainly yes. Animals definitely have the free wills. Just like animal behavior, their behavior can only be predicted to the extend of the joint probability density function. Although animals cannot vote, a stable free society must grant and respect constitutional rights of animals. Protecting the environment is our responsibility for our future generations in next thousands of years.

Question: Do people in United States have too much freedom?

Answer: No. The chapter of quantum politics suggests that people should have maximum freedom, and government must be limited. People in United States could enjoy even more freedom by further limiting the power of the government. The current federal government of United States is too big, powerful, and wasteful.

Question: Why do people have the freedom to choose?

Answer: It is because the world is indeterministic and people have free wills. The movement of the earth around the Sun is approximately deterministic, and the earth does not have any choice to go any other ways. In general, in a deterministic world, everything works precisely like a clock, while in an indeterministic world, everything works like a random walk.

Question: Why is so hard for people to make the connection between the freedom to choose and the indeterministic world? It seems so obvious.

Answer: It is not so obvious for people have not read this paper. Many people do not like to think through these obvious, useless, and unanswerable questions like why we have so many choices. You might try to ask the question to people around you, and see how people react. Among people who really want to think through, very few of them have sufficient trainings in the interpretation of quantum mechanics. Quantum mechanics is viewed incorrectly as relevant only for people who want Ph.D. degree in physics. There are more astrologists than physics Ph.D.s in the world. Among physics Ph.D.s, Copenhagen interpretation has poisoned physicists' understanding of quantum mechanics. Quantum mechanics was created about 80 years ago. Thus, it took 80 years for people to realize a very simple insight that the world is indeterministic after all.

Question: Why is Rational Choice Theory so successful in economics and other fields of social science despite its shaky assumptions about people's behavior?

Answer: Rational Choice Theory is a special case of the Law of Choice. The Law of Choice is a universal law of physics. From Law of Choice, we know that those shaky assumptions about people's behavior are not essential for the Rational Choice Theory to work.

5.4 Questions about Nature of Information

Question: After a person wrote a love poem in the sands, strong winds came and smoothed out the sands. Is the information of the love poem lost?

Answer: Yes. Let's view the love poem, the sands, and the strong winds as an enclosed system. The movements of air molecules in the strong winds are indeterministic. The collisions between indeterministic air molecules and the sands wiped out the love poem. The information of the love poem was

permanently lost as far as the enclosed system is concern. After the love poem was wiped out, the wind creates new patterns of the sands. Those new patterns were recently created new information. Law of Information says that for any enclosed system, historic information is lost and new information is created at any moment because of the indeterministic behavior of elementary particles.

Question: Stephen Hawking and Kip Thorne believed that information was lost after crossing the event horizon of a black hole. John Preskill on the other hand believed that information was not lost. Who is right?

Answer: Stephen Hawking and Kip Thorne were right. Any object that falls into a black hole is torn apart by the strong gravity of the black hole. The tearing apart process is indeterministic, and information is permanently lost during the tearing apart process. The Law of Information says that brand new information is created when the black hole vaporizes through Hawking radiations. There is no such thing as information conservation in physics. It is sad to see Stephan Hawking just switched his position recently. The original view of young Stephan Hawking is right, and the new view of old Stephan Hawking is wrong according to the Law of Information.

5.5 Questions Regarding JJW Interpretation

The JJW interpretation is the theory proposed in this paper. In this section, we will address questions about the JJW interpretation in the question and answer format.

Question: What is new in the JJW interpretation?

Answer: The JJW interpretation solves the measurement problem in quantum mechanics. The JJW interpretation creates the unified theoretical foundation of social and natural science. The JJW interpretation provides ideas and tools to solve problems like unanswerable questions in social science, earthquake prediction, turbulent flow and emerging of human intelligence.

Question: Why do five physics laws of social science sound like common sense rather than the sophisticated theory like Einstein's general relativity?

Answer: The equivalent principle in general relativity also sounds very much like common sense. Yet only Einstein was able to identify that that was a fundamental law of physics. In fact, all physics laws are simple statements about nature.

Although physics laws of social science were first described in this paper, living creatures figured them out billions of years ago. Human brain unconsciously knows every physics law of social sciences and much more. Therefore, human intuition does feel the existence of physics laws of social science.

The human brain is remarkably insightful. Since people deal with uncertainties, information, predicting the future, and making choices all the time, it should be no surprise that physics laws of social science actually sounds like common sense. However, there is endless common sense and it can be only half-true. Only quantum mechanics is able to distinguish those true fundamental laws of nature from those half-truth common sense. Without quantum mechanics, this paper becomes worthless personal opinions.

In many ways, Newtonian laws of motion are also very close to common sense. However, it takes thousands of years to people to formulate the correct Newtonian physics. The road from fundamental laws of physics to common sense is easy. The road from common sense to fundamental laws of physics is very hard.

Just like Newtonian laws of motion and Einstein's general relativity, physics laws of social science actually involve very advanced mathematics when they are used in actual applications. Many details still need to be worked out. The mathematical aspects of physics laws of social science can be very different from people's common sense.

Question: How do you reconcile the JJW interpretation and deterministic Newtonian physics?

Answer: Deterministic behavior is only an approximation while indeterministic behavior is universal. Newtonian physics can be viewed as an approximation of the JJW interpretation. Newtonian physics works exceptionally well in the limits of hard solid objects, because the indeterministic behavior of elementary particles are suppressed in a hard solid objects. However, Newtonian physics fails to describe turbulent flows of liquid or gas, because the indeterministic behavior of atoms and molecules are amplified into the macroscopic length scale in turbulent flows.

Question: Could the JJW interpretation be wrong?

Answer: Possible but unlikely.

1. The JJW interpretation can be tested with experiments.
2. The JJW interpretation leads to many interesting results in social and natural science. Some of these logical consequences can be tested experimentally.
3. The JJW interpretation is an extension of the successful elements of Copenhagen interpretation like indeterministic behavior of elementary particles and Born statistical interpretation of the wave function. The JJW interpretation is not based on empirical evidences. However, the logic consequence of the JJW interpretation seems to agree with empirical evidences and empirical theories. Unlike many other alternative interpretations of quantum mechanics that bring virtually nothing new to

physics and science, the JJW interpretation implies profound implications as described in this paper.

4. If the JJW interpretation is proven wrong by conclusive experiments or by reasoning, it means that either there is something is wrong with existing quantum mechanics or with the logic used in this paper.

Question: Could the JJW interpretation be experimentally tested?

Answer: The JJW interpretation has wide ranging implications in many fields of physics and social science. Those logic consequences can be tested with experiments and social reality.

One simple prediction from the JJW interpretation is that when a person writes down many arbitrary real numbers between 0 and 1 with many digits, at least one number is a random real; Or when a person writes down many long and arbitrary text strings, at least one text string is a random string. The random real and random string is defined as the large Kolmogorov complexity.

From the everyday experience of the internet search, we already know that when a string of digits or texts is long enough, it becomes a unique in the vast internet. This observation supports the view that human writings are results of free wills with the indeterministic quantum nature.

In essence, JJW interpretation predicts that no deterministic computer can generate all the writings by Shakespeare within a reasonable time using a reasonable short computer program.

If such a deterministic computer could indeed be invented, JJW interpretation must be wrong.

6 Answers to 10 Unsolved Problems in Modern Physics

As it turns out, the interpretation of quantum mechanics is not an isolated problem, the interpretation of quantum mechanics is related to many important and unsolved problems in physics.

JJW interpretation of quantum mechanics is a substantial change at the very foundation of modern physics. JJW interpretation has many impacts on physics itself. One application of the JJW interpretation is to provide answers to 10 widely-recognized important and unsolved problems in modern physics [11].

Question 1: What is the solution to the black hole information paradox?

Answer: According to Law of Information, information is constantly destroyed and constantly created. When physics objects fall into a black hole, the objects are torn apart into elementary particles, and much of the information is destroyed during this irreversible process. JJW interpretation provides no insight whether

there is black hole radiation. If there is back hole radiation, new information will be created. Therefore, there is no paradox.

Question 2: What is the nature of time?

Answer: In JJW interpretation, time is a quantum phenomenon and time is very different from space. In special and general relativity theory, the space and time are the same in the 4-dimensional spacetime. It is not clear how to reconcile the obvious contradictions regarding the concept of time between quantum mechanics and special and general relativity theory.

Question 3: Is time travel possible?

Answer: In JJW interpretation, the past and future universe does not even exist. Therefore, there is no way to travel into some ono-existent world. However, time is a local phenomenon that depends on the reference frame.

Time can go slow down or speed up locally without running into any contradiction with laws of physics. In that sense, a refrigerator is a time machine. If the temperature is close to the absolute zero, the clock virtually stops because nothing changes. Therefore, a bacteria or virus could be frozen for thousands of years without any change and reactivate again. We do not know whether human could be frozen for thousands of years and awaken up again. In that sense, time travel is simple and time machine is already in every home.

Question 4: Why does time have a direction?

Answer: Choice is a fundamentally time irreversible physics phenomenon. The arrow of time phenomena in all fields of physics including social science is direct results of choices. Law of equilibrium is the generalization of the second laws of thermodynamics.

Question 5: What is the solution of measurement problem in quantum mechanics?

Answer: If all human behavior including the measurements can be described by quantum mechanics, the measurement problem in quantum mechanics disappears completely. In a sharp contrast with the Copenhagen interpretation, all human behavior including the measurements can be described by quantum mechanics in JJW interpretation.

Question 6: How to extend the success of the second law of thermodynamics to the physical systems far away from the thermodynamic equilibrium?

Answer: We can generalize the second laws of thermodynamics into Law of Equilibrium, which is applicable in physical systems far away from the thermodynamic equilibrium including the human society.

Question 7: What is the nature of turbulence?

Answer: The turbulent flow is a quantum phenomenon. At the atomic level, the liquid flow is always chaotic. In the turbulent flow, the indeterministic nature of atomic movements is magnified into the macroscopic scale. The similar magnification near the critical point in the second order phase transition is well recognized.

Question 8: What is the nature of stochasticity of gene expression in biology?

Answer: The stochasticity of gene expression is an indeterministic quantum phenomenon. The gene mutation is one type of choice according to Law of Choice.

Question 9: What is the physics underlining Darwinian evolution?

Answer: The Darwinian evolution is a macroscopic quantum phenomenon. While the Darwinian evolution is not consistent with the second law of thermodynamics, the biological evolution is governed by physics laws of social science.

Question 10: Are there physics laws governing human society?

Answer: Physics laws of social science govern the behavior of human and human society.

8 Short Description of Framework of Quantum Social Science

The most interesting application of JJW interpretation is to provide a rock solid physics foundation for all fields of social science [12, 13], and all problems in economics [14, 15], politics [16-19], and other social science become physics and engineering problems. The following is a short description of the framework of quantum social science, and the detailed description will be published elsewhere.

8.1 Economics

In economics, a fundamental equation of economics (FEOE) [14], which is similar to many fundamental equations governing other subfields of physics, for example,

Maxwell's Equations for electromagnetism, can be derived from physics laws of social science (PLSS). FEOE is the one mathematic equation that governs all observed economic phenomena. The fundamental equation of economics establishes a common entry point to solve all economic problems. FEOE is a mathematical bridge connecting the current economic reality and all future possibilities. Establishing FEOE clarifies many open questions regarding the foundation of economics, for example, what can be forecasted and what cannot be forecasted in economics. FEOE comes with its own version of microeconomics and macroeconomics.

In microeconomics, by the definition, which is traditionally assumed by most economists as the foundation of economics, is replaced by a new model called indeterministic supply demand pricing (ISDP) model derived from FEOE [14]. ISDP model is far more precise and universal mathematical abstraction of market reality than the framework of Marshall's laws of supply and demand and market equilibrium [20]. For example, the traditional framework of economics could not handle the concept of inventory in a logically consistent way because the existence of inventory invalidates the entire framework of laws of supply and demand and market equilibrium. Existing inventory in a market means by the definition that supply always greater than demand, and therefore in reality, there is no such thing as the market equilibrium defined as supply equals demand. The central tenet of Marshall's cross diagrams is the intersection of supply and demand curves. Because inventory means supply is always greater than demand, the existing of inventory means that the supply and demand curves will never cross. However, in a free market based economy, most products have inventories. An ISDP model can handle the inventory without any problem. In the traditional economics, In the FEOE framework of Marshall's laws of supply and demand and market equilibrium works only for the perfectly competitive markets with many buyers and sellers. The perfect competitive market is like a fairy tale that does not exist in reality.

Although general equilibrium theory has been widely regarded as one of landmark achievements of traditional economics [20], general equilibrium theory is not compatible with FEOE. It is simply because the general equilibrium theory is also built upon the fairy tale concept of the perfect competitive market. In general, the market is not in a static state of equilibrium. PLSS clarifies the widespread confusions among economists regarding the concept of equilibrium and disequilibrium. There is only one definition of equilibrium for all subfields of physics including economics.

The nature of the "invisible hand", which efficiently organizes the worldwide economic system, has been in great interests to economists. In physics, there are similar invisible hands in many physical systems. For example, snowflakes are spontaneously self-organized into beautiful symmetric patterns. If money is viewed as socialized free energy, then two invisible hand phenomena in economics and physics are the same phenomena with similar dynamics. In physics, the "invisible hand" is characterized by the maximization of entropy or minimization of the free energy depending on the boundary conditions. In economics, the "invisible hand" is driven by the principle of the maximization of wealth, which is money or socialized free energy. In the FEOE framework, the general equilibrium theory is replaced by the principle of the maximization of wealth.

In macroeconomics, FEOE translates into the Indeterministic Balance-sheet Plus (IBSS+) model [15] and rejects popular DSGE models and Agent-based Computational

Economic (ACE) models. FEOE is fully compatible with national account system. IBS+ models can be viewed as a natural extension of current and historic data captured in national account system. Like many models in physics, the IBS+ model is universally applicable in any kind of economy, empirically falsifiable, making forecasts with reasonable accuracy, truthful abstraction of reality, capturing macroeconomic dynamics accurately, and most importantly based on a sound theoretical foundation. Recent experience during the great recessions of 2008 has shown that the accounting models have worked significantly better that DSGE and ACE models.

In conclusion, FEOE provides a solid physics foundation for both theoretical and practical economics. After establishing FEOE, there should be no doubt that economics is simply a branch of quantum physics in parallel with chemistry and optics. Over last four hundred years, there are many schools of thoughts emerged in economics while there is only one school of thought by Newton-Einstein-Bohr survived in physics over the same period. The logic conclusion is that there must be only one school of thought allowed in economics as a subfield of physics.

8.2 Political Science

Solving the humanity governing problem [16] is probably the most important contribution of JJW interpretation of quantum mechanics. One problem is standing out above all others in social science: how should humanity govern itself? The problem is so important that all wars of humanity in the past, present, and future, are directly related to this problem. Despite the fact that this problem has attracted interests of some greatest thinkers for thousands of years: Confucius, Plato, Aristotle, Machiavelli, Locke, Washington, Jefferson, Madison, Kant, Marx, Einstein, Hayek, and many others, yet the problem remains unsolved. The latest thinking on this governing problem by mainstream social scientists is represented by views of Friedrich Hayek. In his writings, Hayek repeatedly warned that we must shed the illusion that we can deliberately create the future of mankind. With PLSS, we disagree with Hayek and prove that this problem is a many-body problem in physics solvable scientifically after all applying recently-created physics laws of social science, if the problem is formulated in a correct way: what kind of governing political structure of humanity is most stable? Most-stable structure problems appear routinely in the theoretical and experimental condensed matter physics. We show that the humanity governing problem is equivalent to find an equilibrium political structure of a human society, which is a many-body physics problem 100% solvable using the maximum entropy approach widely-used in the condensed matter physics. PLSS establishes the framework and methodology of quantum politics and replaces traditional political philosophy with quantum physics as the solid foundation of political science, and analyzes the equilibrium political structure of a human society. Quantum politics says that we can create free, fair, just, peaceful, and prosperous human societies. We prove that there is certainly no better alternative than the equilibrium political structure, which is defined by a set of 16 democratic principles. Quantum physics clearly says that there is a global political equilibrium state, which corresponds to the permanent world peace. This paper provides a theoretically-sound and practical solution to eliminate the nuclear, biological, chemical, robotic, and other forms of weapons of massive destruction. In the long run, humanity can finally grow up and will put an end to deaths,

miseries, and economic destruction caused by wars, which have been plagued us since the dawn of humanity.

Treating the human society as many-body problems in physics naturally leads to extend the hydrodynamic mode methods [18] in the condensed matter physics to analyze the human society to answer an important question of social science: what drives the economic, political, and social changes in the human society? In a simple fluid like water, the macroscopic changes are characterized by 5 hydrodynamic modes in connection with the conservation laws of energy, mass, and the 3-dimensional momentum vector. The conservation of momentum and the Newton's second law of motion lead to the well-known Navier-Stokes hydrodynamic equation. In human society, there are millions and billions of changes every day. The hydrodynamic mode approach says that most of these changes in human society are transient and short-term changes. In the long run, only changes characterized by the hydrodynamic modes are relevant. In the human society, there are 16 hydrodynamic modes in connection with the equilibrium political structure of the permanent world peace. It is a very surprising conclusion that despite the complexity of human society, the only important drivers of the long-term political, economic, and social changes in the history, present, and the future are these 16 classes of global mega-trends associated with hydrodynamic modes.

Studying the political equilibrium structure leads to a conclusion that the US constitution has many fundamental design flaws. American civil wars, slavery, epidemic gun violence, and run away government debts are some direct results of design flaws of the US constitution. The constitution is certainly one of the most important documents in the world history. It was designed wisely and beautifully by US founding fathers. However, the constitution was written by a group of farmers with limited knowledge of political theories one and a half centuries before quantum mechanics was created. We now know the foundation of political science is quantum physics. Also the constitution was a practical legal contract out of compromises. Even though many founding fathers knew the slavery was wrong, they did not grant the equal rights to slaves. They declared all mans are created equal. Yet they gave more representation to states with less population in the senator seats.

Today many social and economic problems in US can be traced to the fundamental design flaws of the constitution [17]. The principle of fiduciary duty requires the congress to treat the future generation fairly. However, the running away federal fiscal deficit is a clear sign that the congress has failed their fiduciary duty. The US constitution fails to constrain the congress with their fiduciary duty to the future generations. The epidemic gun violence in US is the direct result of the right to bear arms in the second amendment of the constitution. The principle of nonviolence says that conflicts should be resolved peacefully with compromises. Historically, American civil wars and slavery are some other examples of the design flaws of the US constitution. Because the 16 democratic principles are universally applicable to any countries, the comparison can be made between the political structure of any country and the equilibrium political structure. These results will have important practical implications.

Studying the political equilibrium structure also leads to solve one of most intractable and contentious problem in modern political economics [19] in a value-free way. The debates about how to deal with government budget deficits are raging all over the world. In US, the federal government forced to shut down for 16 days in 2013

because of the failure to pass a budget through congresses, and barely averted a default of federal government obligations due to failure to raise the federal debt ceiling limit. The city of Detroit filed the largest municipal bankruptcy in the US history on July 18, 2013, despite Michigan State constitution's balanced budget requirement. In Europe, the sovereign debt crisis has dragged down the entire EU economy since late 2009 with no end in sight. In Japan, the government debt to GDP ratio is well over 200%, which is one of the highest in the world. In the world of academics, the debates of government deficits have become the key battlegrounds of different schools of thoughts of economics. Economists and political scientists could not even agree to a framework to solve these issues, let alone settle these debates. Quantum politics provides a permanent solution to government budget deficits. Surprisingly the solution comes from the first principles of quantum physics. The political equilibrium structure has the time translational symmetry in treating different generations equally. One result of applying physics laws of social science to study the most stable political structure is that the most stable political structure is not only to require the majority voters must deal with minority voters fairly to avoid the tyranny of the majority, but also to require the voting generation must exercise their fiduciary duty to their children and future generations. In terms of government budget deficits, the fiduciary duty means that the current voting generation must take the full responsible of the current government budget deficits or surplus. The permanent solution of government budget deficits is legally and personally held the voting generation accountable for the current fiscal surplus and deficit at all level of governments. In contrast to the balanced budget approaches, the permanent solution in this paper allows deficit spending and government debt as long as the government debt must be paid off by the responsible borrowers and voters. The method to solve the government budget deficit problem is an excellent example of applications of law of equilibrium, which can be used to solve economic, political, and other social problems in a value-free way. The permanent solution to government budget deficits presented in this paper is consistent with a different line of reasoning in economics, which is known as the tragedy of the commons. In cases of government budget deficits, the tragedy of fiscal abuse happens because the exact ownership of government budget deficits by which generation is unclear in the US constitution, and current voting generation financially takes unfair advantage of their children and the future generations, who virtually have no political power.

In conclusion, JJW interpretation of quantum mechanics provides a solid physics foundation for political science. There should be no doubt that political science is simply a branch of quantum physics in parallel with economics, chemistry and optics. Establishing quantum politics is a giant step forward for the humanity because for the first time we can solve contentious political problems in a scientific manner.

9 Conclusion

This paper covers many subjects about human choices. A coherent physics theory of human choices requires a brand new interpretation of quantum mechanics. Unlike many other interpretations of quantum mechanics, JJW interpretation of quantum mechanics has profound logical consequences including establishing generalizing the second law of thermodynamics, establishing the fundamental equation of economics, and solving the humanity governing problem. Therefore, judging from these logical

consequences, we believe that JJW interpretation of quantum mechanics is the only correct interpretation of quantum mechanics.

10 Reference and Notes

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