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A Physics Solution to the Hardest Problem in Social Science: Physics Foundation of Permanent World Peace

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Abstract

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 humanity 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. This paper disagrees with Hayek and proves for the first time that this problem is solvable scientifically 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. This paper 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. The main results are quite surprising: (1) Quantum physics does provide a firm scientific foundation for social science. For the first time, political science, economics, and other social science become branches of quantum physics just like optics and chemistry. (2) Quantum physics 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. (3) The existing democratic governments in the world can be improved in significant ways. For example, there are many fundamental design flaws in the US constitution. American civil wars, slavery, epidemic gun violence, and run away government debts are some direct results of design flaws of the US constitution. (4) 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 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.

1. Introduction

During her speech at American University in Cairo, Egypt on June 20, 2005, United States Secretary of State, Dr. Condoleezza Rice, declared, "Together, they are defining a new standard of justice for our time -- a standard that is clear, powerful, and inspiring: liberty is the universal longing of every soul, and democracy is the ideal path for every nation."

Why is liberty the universal longing of every soul? Why is democracy the ideal path for every nation? Without a solid theoretical foundation, Dr. Rice's speech sounded hollow. While it was very inspiring for sure, the speech was just her political philosophy and her personal opinions. For thousands of years, everybody from ancient Greek philosopher Plato to Dr. Rice has their own political philosophies and their own opinions about freedom and politics. Egyptians have already learnt the concept of democracy for thousands of years from their neighbor City State of Athens. Why should people in Egypt have to listen to Dr. Rice now? What if there are better alternatives than the American-style democracy? What if she is wrong? People in Egypt know all too well the painful social experiments of socialism, and communism in Cambodia, North Korea, Soviet Union, China, and other countries. Not that long ago, Marxism was clear, powerful, and inspiring too. Things would be different if there were physics laws of social science, which could distinguish personal opinions from universal truths of nature.

For thousands of years, people have been searching for better ways to govern themselves, and we are still searching today. In the Middle East, discussions on democracy and Islamic traditions are raging. In many countries around the world, socialism and communism are still viewed as valid alternatives to capitalism. Recently several countries in South America made sharp left turns to socialism ideologies. Even in mature democratic societies like US, recent experience of the great recession of 2008 pushed many people to question whether there are better alternatives than our capitalism.

Questions about governments and political systems are no small matters. Most wars if not all wars were historically fought for gaining the control of political powers. Sadly even today, deaths, miseries, and sufferings of wars continue. Looking into the future, to most people, the hope of the world peace is nothing other than an idealistic dream. Many countries are busy to develop and purchase advanced weapons for future wars. According to the Stockholm International Peace Research Institute Yearbook 2013 [1], the global military expenditure surpassed the \$1.756 trillion mark in 2012, representing 2.5 per cent of global gross domestic product (GDP) or \$249 for each person in the world. In last two decades, at least three additional countries India, Pakistan, and North Korea joined the club of nations that possess nuclear weapons. Iran is also very close to becoming a nuclear power. With rapid advances of genetic engineering and robotics, the threats of deadly biologic and robotic weapons are ever increasing. Despite wishes of most people on the planet to get rid of the threats of nuclear, biological, chemical, robotic, and other weapons of massive destruction, the international disarmament talks have gone nowhere. Why has humanity always been cursed by ever more destructive wars?

While ideas of democracy and human rights are popular around the world today, there are still many doubts in every corner on the earth. Are there other better alternatives

than democratic governments? Are the democratic principles really scientific? How should we balance religion and traditional values with democratic principles?

To answer these difficult questions discussed above, this paper takes a scientific approach instead of traditional political philosophies. Traditional political theories are based on political philosophies. While arguments from traditional political philosophy can be persuasive, without a scientific approach based on fundamental laws of physics, people are always wondering the universality of democratic principles.

The paper is structured as the following. We will first discuss five physics laws of social science. Then we will establish the physics foundation of political science, the framework of quantum politics and discuss the physics of human free will. Then we will formulate the humanity governing problem into a format, which is 100% answerable by science. We will provide the answer of the equilibrium political structure by establishing a set of 16 democratic principles derived from the physics of free will and physics laws of social science. We will show that a political system based on these democratic principles must be the long-term political equilibrium state, which corresponds to a free, fair, just, peaceful, and prosperous human society. Because laws of physics are universally valid, these democratic principles must be applicable to both individual nations and the world. In the global scale, the resulting democratic world government corresponds to the permanent world peace. After presenting theories of quantum politics, we will discuss some impacts of solving the humanity governing problem.

2. Five Physics Laws of Social Science

One of the most fundamental questions in social science is whether exist universal physics laws governing the human society, which would unify all knowledge of social science, in the same manner fundamental laws of physics unify all knowledge of natural science.

An important clue that leads to establish physics laws of social science is the fact that fundamental concepts in social science, such as choice, information, causality, uncertainty, equilibrium, and arrow of time, are also shared by many fields of natural science. In the framework of modern physics, these concepts can be defined precisely in the language of physical mathematics. After reconciling the human behavior with the existing framework of modern physics, five physics laws of social science, which are universally applicable to all fields of social and natural science, can be formulated.

The starting point of establishing a scientific foundation for political science is the five physics laws of social science, which have been published elsewhere in a book [2] and an academic paper [3]. For the benefit of readability of this paper, we list five physics laws of social science in the following.

First Law – Law of Indeterminacy

For a closed system, the outcome of any future event in the system 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 in the system 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 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 of a closed system.

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 equilibrium states.

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 causality relationship of an indeterministic system. The Law of Choice addresses how to make a choice and the flexibility and plasticity of an indeterministic system. The Law of Information addresses how information is created and destroyed. The Law of Equilibrium, which is the generalization of the Second Law of Thermodynamics, addresses the direction of time and the equilibrium state of an indeterministic system. These five fundamental laws of physics are profound statements about the nature and human societies.

The explanation and discussion of these five laws can be found in the book [2] and the paper [3]. These laws are fundamental laws of physics, which are applicable to any system including any physical and biological systems, and human societies. Establishing a fundamental equation of economics governing all economic phenomena is one application of these physics laws in economics. Five physics laws of social science can be viewed as an extension of quantum physics to macroscopic systems. Many macroscopic phenomena like human free will could only be explained fully by applying quantum physics.

3. Physics Foundation of Political Science

In this section, we apply physics laws of social science (PLSS) to establish the physics foundation of political science by answering some most important questions of

political science: what is the nature of human conflicts? What is the human natural in the new framework of quantum politics? What is the physics nature of human free wills? How to apply PLSS to solve political problems?

After these most fundamental questions of political science are answered with PLSS, we have successfully replaced the traditional political philosophy with quantum physics. Thus the political science becomes a branch of quantum physics just like chemistry and optics.

3.1 Physics of Human Conflicts and Human Conflict Paradox

At the first sight, two ancient disciplines: physics and politics are two more or less unrelated fields. Through a simple thought experiment, we will show that two fields actually share the exact same physics foundation, and the physics nature of human conflicts is the human conflict paradox in quantum physics defined as the following: on one hand, physics laws allow human free wills to have conflicting visions of the future; on the other hand, the same physics laws allow any one of the visions to become reality but forbid any conflicting vision of the future to become realized as the physical reality.

Consider a wooden table and a wooden chair in a well-defined environment of a physics lab. The behavior of the table and chair in the lab setting is well described by the Newtonian Physics. There is no surprise here.

Now consider a husband and wife in the same well-defined physics lab setting. The husband and wife pair can display amazing varieties of interesting behavior: loving, kissing, having sex, conflicting, bargaining, fighting, killing each other, talking, and much more. The behavior of the husband or wife certainly cannot be sufficiently described by the Newtonian physics because the Newtonian physics could predict none of the couple's behavior observed in the lab.

From the physics point of view, why is the behavior of a pair of table and chair and a pair of husband and wife so different, although organic molecules involved in these two experiments are not all that different? The short answer is that the husband wife pair has free wills while the table chair pair does not. If the husband and wife are sleeping, under general anesthesia, or simply dead, then the behavior of the husband and wife pair in the physics lab setting can be well described by the Newtonian Physics.

Because both the wooden table chair pair and the husband and wife pair are governed by the same PLSS, there is a common physics foundation for both human society and physical world.

In our thought experiment, let's say both the husband and wife wants to sit a same chair alone at a same moment. Instantly, we have a conflict of two free wills. It is the same laws of physics that allow the husband and wife to have a conflicting vision of what to do next, and then allow either of visions but forbids both two conflicting visions to become a reality at the same time. Laws of physics do not allow the same physical space been occupied by two human bodies at the same time. However, if the husband and wife were the Oxygen and Nitrogen gas, laws of physics would have no problem to allow the Oxygen and Nitrogen gas to share the same physical space like an empty bottle by mixing at the same time. The laws of physics even go further, as time goes by, the conflicting vision must be resolved one way or the other, because some events must

realize as the physical reality at a fixed point of time. Therefore, both the cause and the resolution of human conflicts are physics.

Another example is from the current world politics. In recent years, the US government has repeatedly demanded Iran to stop enriching the nuclear materials. The Iranian government refused. Here we have a conflicting vision of the future in the real world. The physics laws would not allow both of the two conflicting of visions become a reality.

The central topic of political science is human conflicts. The free will and conflicts among free wills are quantum phenomena. Thus, political science must be a branch of quantum physics. The physics nature of human conflict is summarized as the human conflict paradox in quantum physics: physics laws allow free wills to have conflicting visions of the future, and then physics laws forbid any conflicting vision of the future to become physical reality.

3.2 Resolve Human Conflicts through Quantum Physics

The next burning question is how physics can help the humanity to resolve their inevitable conflicting visions of the future?

As a science, physics does not care which vision of the future becomes the reality. Physics is all about forecasting the future. If there is a physics theory that allows us to forecast which of conflicting visions of the future would realize as the physical reality, the physics theory will be both quantum physics and politics at the same time. In this paper, we call this kind of physics theory as quantum politics in order to distinguish it from the tradition political science.

Because PLSS allows us to forecast the future scientifically, in essence by applying PLSS, quantum physics already embeds the resolution of human conflicts in terms of mathematical language of probability.

3.3 The Framework of Quantum Politics

Quantum politics is a field studying political phenomena using quantum physics. In this section, we describe the framework of quantum politics.

The traditional political science [4-10] is divided into two fields of very limited overlapping: the positive and normative political science. The positive political science is an empirically based study on political phenomena as “what is” in a value-free manner. The normative political science, often called political theory or political philosophy, concerns about the political questions of “what ought to be”. Traditionally, these two fields have been widely separated with relatively little cross-fertilization [4]: theorists do not undertake rigorous empirical data analysis; empiricists do not undertake rigorous philosophical reasoning.

The quantum physics divides political science into three distinct fields with strong overlapping on forecasting: the value-free positive quantum politics, the not-value-free normative quantum politics, and the value-free normative quantum politics. The positive quantum politics emphasizes forecasting rather than empirical data analysis. The not-value-free normative quantum politics combines forecasting with the value system to solve political engineering problems. The value-free normative quantum politics applies

PLSS to solve one special class of political engineering problems in a value-free manner. All these three fields emphasize on applying PLSS to forecast. We discuss these three fields in details in the following sections.

3.3.1 Quantum Politics Focuses on Forecasting

In all subfields of physics, the focus of physics is always on forecasting. Quantum politics is no exception. The heart and soul of quantum politics is to forecast the future evolution of political phenomena.

Quantum politics sets the very high standards for forecasting in politics in order to be consistent with modeling in other subfields of physics. Quantum politics requires the a scientific forecasting model in politics to be logically self-consistent, making forecast with reasonable accuracy, truthful abstraction of initial reality, capturing key dynamics accurately, and based on a sound theoretical foundation.

In physics, the requirement of scientific forecasting is very high. For example, there are many ways to forecast when the sun will rise next morning. One could guess the answer; one could extrapolate data from last few days; or one could built a full Newtonian solar system model using Newton's laws of motion and law of gravity. Only Newtonian solar system model is a truly scientific model that is logically self-consistent, making forecast with reasonable accuracy, truthful abstraction of initial reality, capturing key dynamics accurately, and based on a sound theoretical foundation.

In quantum politics, not all forecasting model are acceptable as the scientific forecasting. For example, there are many ways to forecast who will win the next presidential election in US. One could guess the answer; one could built a simple regression model with a few economic and political variables; or one could built a full probabilistic model like the Nate Silver's fiveThirtyEight presidential model [11], which based the election college map and the state-based political dynamics. The fiveThirtyEight forecasting model would satisfy many listed requirements of a scientific model.

While the traditional positive quantum politics emphasizes the empirical data analysis, the positive quantum politics emphasizes the initial reality and future dynamics and deemphasizes the importance of the empirical data. From empirical data alone, one could wrongly conclude that no female or African American would ever become the president of the US before Obama was elected in 2008.

In most subfields of physics, the empirical data are usually irrelevant at the top level. To forecast the future motions of planets around the sun, only the initial condition of planets and laws of physics are needed. The historic data are not required. Although historic empirical data could be useful to back-test the forecasting model, that importance is secondary. At the top level, the historic data has no use and not required in all fields of physics, which must include quantum politics.

In practice, empirical data are critical for calibrating and back-testing the forecasting models. When empirical data are used, we are assuming the history will repeat itself in some fashions. In social science, because people have free wills, there is no guarantee that history will repeat itself. Figuring out what will repeat in the future is the heart and soul of the political analysis using the fundamental equation of politics.

In conclusion, the heart and soul of quantum politics is forecasting. Like other branches of physics, quantum politics sets a very high standard for the scientific forecasting models.

The easiest way to achieve the high forecasting standard required by quantum physics is to model political processes using the fundamental equation of politics.

3.3.2 Fundamental Equation of Politics

For any forecasting model in politics, the first question and the most fundamental question in quantum politics is always what is predictable and what is not predictable. The question can be answered by deriving a fundamental equation of politics from PLSS.

Law of prediction of PLSS states that for a closed system, any future event in the system 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 quantum mechanics.

Let φ be the unique and objective joint probability distribution function of selected state variables, the law of prediction translates into the **Fundamental Equation of Politics (FEOP)**.

$$\frac{\partial \varphi}{\partial t} = H \varphi$$

Here H is an operator. In principal, for a closed system of human behavior and human society, H operator is precisely defined by quantum mechanics. At this stage, we do not know to define H exactly starting the atomic level interactions. We do know that, however, H operator does exist and is uniquely defined because of law of prediction. For all practical purpose, as long as H exists and is uniquely defined, we could always construct an approximate H operator from empirical data and physics laws, and then compare the forecast against the future outcome. The difference between the realized outcome and model expectation provides the needed feedback to further improve the forecasting models. The initial condition $\varphi(t=0)$ reflects the existing political reality. As a example, Feymann-Kac equation [12] for the option pricing theory in finance can be viewed as a special case of FEOP.

FEOP is exactly the same as the fundamental equation of economics [13]. For the detail derivation of FEOP from PLSS, please see the reference [13]. Because traditionally politics is a completely separate field from economics, it is awkward to use the fundamental equation of economics in the political modeling. Also while economy might be viewed as a sub-system of the grand political arrangements, logically it is difficult to justify calling politics as a subfield of economics. Therefore, it is natural for quantum politics to have its own fundamental equation.

In essence, FEOP is the mathematical bridge connecting the current political reality and all future possibilities.

3.3.3 How to Falsify a Political Theory

One very old and very important question in political science is how to falsify a political theory [14]. The communism movements in the 20th century have claimed about 100 million victims around the world [15]. One could only wish that a political theory like communism could be first experimented carefully in a small and limited scale before it was fully implemented in some biggest countries in the world.

In last one hundred years, the world has witnessed the dramatic rise and fall of communism. The stunning contrasts of political, social and economic developments between North Korea and South Korea and also between East and West German demonstrate empirically and that there are clear right and wrong in political theories. However, only science could have right and wrong. Therefore, political theories must go beyond traditional political philosophies.

A quantum political theory should always meet Popper's falsifiability requirement of a scientific theory [14]. In the framework of quantum politics, a political theory that is not falsifiable is meaningless. A quantum political theory is a physics theory of human free wills and not a philosophic theory. Because quantum politics emphasizes forecasting, the predictions can be compared with the future outcomes in order to falsify a political theory.

However, because the forecasts made by the fundamental equation of politics are probabilistic in nature. To falsify a quantum politics model often requires many repeated observations. Take the rock-paper-scissor game as a simple example. One could build many different forecasting models for the future outcomes. These forecasting models are falsifiable with the relative entropy measures from the information theory with sufficient repeated observations.

3.3.4 Normative Quantum Politics

Political decisions often impact the lives of many people. The normative quantum politics is a tool to make the political decisions as scientific as possible.

With the fundamental equation of politics, the future possibility can be forecasted, and the consequences of different political choices can be predicted. However, in order to evaluate the consequences of different political choices, one must use the value system. In the framework of quantum politics, the value system is fundamentally important but is not part of science. In physics, many engineering questions cannot be answered by science alone. For example, which exterior color should be used for a car is not answerable by the value-free science alone.

However, in quantum politics, there is one important class of political problems that can be solved with the value-free physics.

3.3.5 Normative Political Problems Solvable by Value-free Physics

One of key contributions of quantum politics is to provide a scientific framework to solve some normative political problems with the value-free physics.

Take a close look at the question how two identical twin brothers should divide a cake. One could use different value systems to justify different ways to divide a cake. However, one solution standing out above all others is to divide the cake symmetrically by half. In this case, the symmetric division is a solution rising beyond the value-system.

In the framework of quantum politics, the fair division problem can be framed in terms of observing two identical twin brothers how to divide a cake in an isolated laboratory environment. The law of equilibrium gives an equilibrium probabilistic distribution of the size of cake that one of brother gets. It is reasonable to expect the equilibrium distribution is symmetric with the peak probability density centered on the symmetric division.

In essence, the law of equilibrium corresponds to the result as if the division of cake experiments is repeated many times. Because law of equilibrium is a value-free analysis, law of equilibrium provides an important method to solve the normative political problems in a value-free manner.

The equilibrium method is widely used in other branches of science. In the condensed matter physics, while the movements of water molecules are indeterministic, when the temperature is below freezing, the water molecules would spontaneously organize into the equilibrium state of ice crystals. In medicine, there are many ways to treat male impotence. After the invention of the magic blue pill of Viagra, the Viagra becomes the obvious choice. If one plots the probability distribution of the physician's choice of the impotence drugs, the equilibrium probability density function would sharply concentrate on Viagra. The law of equilibrium tells what the all possibilities are and also tells what the most likely possibility is.

The law of equilibrium is closely related with the equilibrium method in game theory. The difference is that game theory is essentially a rational choice theory with the assumed probability distribution functions, while the law of equilibrium is a law of physics with the probability distribution gave by quantum physics. Generally speaking, the rational choice theory is incompatible with quantum social science because the concept of rational cannot be defined scientifically. Therefore, in many cases, the Nash equilibria given by game theory might not agree with the observed human behavior [16-18]. Thus the game theory becomes a mathematical tool in a broad framework of quantum politics.

The forecasts made by the law of equilibrium are falsifiable. Usually the law of equilibrium corresponds to the long-term equilibrium state forecasts while the law of prediction and the fundamental equation of politics can be used both short-term and long-term forecasts. In essence, the law of equilibrium is a special case of the law of prediction.

Take a simple morality question as an example: whether people could steal? This normative question is obviously one of the oldest questions of humanity. For thousands of years, philosophers and average people have constantly arguing whether such a basic question has a simple and absolute right or wrong answer. With law of equilibrium, there is a scientific answer to the question. First we reformulate the normative problem into a related question answerable by science: in the long run, what is the probability that a person on the earth will steal in a day? This question is a forecast of the future and is answerable with law of equilibrium and law of prediction, which produce the future probability. Empirically from the crime statistics, we already know that the probability of stealing for an average person in a day is very low. Because there is a powerful causality relationship between stealing and bad consequences following stealing in any human society, we can forecast that the future probability of stealing will be very low in the long run. The forecast by law of equilibrium has many very interesting features: (1) it does not

answer directly whether stealing is good or bad. However, it does forecast that the future probability of stealing will be very low. Therefore, it implies that stealing must be bad. Otherwise, people have free wills and would steal more often in the future. (2) There have been mountains of writings by philosophers regarding whether the human morality is absolute or relative. The law of equilibrium answers the question by quantifying the degree of absoluteness of morality. If the future probability is 100% or 0%, it is absolutely right or wrong to steal. In our case, it is very low probability. Thus one could say that it is very wrong to steal but not absolutely wrong. (3) In some chaotic political situations, the crime rate of stealing would be sky-rocketing temporary. Law of equilibrium says that after the chaos is over, the morality rule will spontaneously re-establish itself in the long run average. The morality rule of do-not-steal is a spontaneous order of the human society. In essence, law of equilibrium says that the morality rule of do-not-steal is timeless and reflects something deep about the humanity. (4) The law of equilibrium and more general PLSS methodology is physics not philosophy. The forecast can be falsified by comparing with the future crime rates.

Not all normative problems could be answered by the law of equilibrium. Only when those problems could be framed into a closed system with a long-term equilibrium state, the law of equilibrium will be applicable.

In politics, there are many normative problems could be answered by the law of equilibrium because many problems in politics are timeless just like the equilibrium state. Timeless means that the problem has been with us for a long time and will always be part of humanity forever. The fair division problem is timeless. The laws and rules governing many organizations like governments, universities, schools, families, and other political organizations are timeless. The equilibrium state like the ice crystal structure in physics is timeless.

Of course, the most important question in politics is how humanity should govern itself. This paper will show that this most important problem in politics is answerable by the law of equilibrium.

3.3.6 Quantum Physics Replaces Traditional Political Philosophy

Politics is one of most fascinating and ancient fields of inquiry of humanity. Over thousands of years, humanity has witnessed many different political thinking represented by many key historic political philosophers [19-24] like Confucius, Plato, Aristotle, Machiavelli, Locke, Jefferson, Madison, Kant, Marx, Hayek, and many others. Some popular recent political philosophies include authoritarianism, conservatism, liberalism, socialism, communism, anarchism, and environmentalism.

In traditional politics, the political theory and political philosophy are often used interchangeably. That is not the case in the quantum politics. A political theory in quantum politics is a physics theory about the political reality based on quantum physics and physics laws of social science, while traditional political theory is political philosophy.

The requirement of a good political theory in quantum politics is well beyond the requirement of Popper's falsifiability. It must the all standard requirements of a physics theory. Most political philosophies would not come close to physics theories. However, many political philosophies are abstracts of the observation of the political dynamics for

thousands of years by many greatest thinkers in history. It would be not surprising that many political philosophies will be preserved in a new scientific language of quantum politics. Careful examinations of political writings of thousands of years under the new framework of quantum politics would be a fascinating future research topic.

As we discussed earlier, science cannot solve many normative political problems without the value system. Because the value system is the mixture of theology and philosophy, the theology and political philosophy are preserved and co-exists peacefully with the scientific theories of quantum politics.

In conclusion, we have presented the framework and methodologies of quantum politics. In next section, we take a close look of the physics of human free will, which is the foundation of quantum politics.

3.4 Quantum Physics of Free Will

One of central hypothesis of this paper is a claim that the free will of a human being is a quantum phenomenon or a managed quantum uncertainty. In this section, we will summarized key ideas of the physics of free will in order to make the paper self-contained, while detailed analysis of will be published elsewhere.

In philosophy, free will means that during our decision-making processes, our final choices are ultimately up to us. Although the human free will is an everyday phenomenon, the exact nature of free will has been debated for over thousands of years and we are still debating today. It has been waiting far too long to move the discussion of free will from philosophic debates to rigorous scientific researches.

Because the complexity of human brains, the precise nature of human free will is very difficult to answer directly. However, the question can be answered indirectly. As it turns out, free will is a fundamental feature of all mobile bacteria and animals. In the case of E. Coli bacteria, their decision-making processes has been worked out in details through series of experimental observations [25]. Just like human, E. Coli bacteria are able to swim around to search foods and avoid harmful chemicals at their own free wills. E. Coli bacteria are propelled by spinning molecular motors, which can rotate clock clockwise or counterclockwise. When the motor rotates counterclockwise, the helical filaments of flagella [25] of bacteria form a coherent bundle and the bacterium swim smoothly in a straight line. When the motor rotates clockwise, the helical filaments of flagella cannot form a coherent bundle because the screw-sense of the helical flagella does not match the direction of motor rotation and the bacterium tumbles and changes its swimming direction unpredictably. The tumbling process takes advantage of instantaneous microscopic quantum uncertainties in the surrounding water molecules. E. Coli bacteria adjust their swimming behavior by managing the frequency of indeterministic tumbling processes. Overall, E. Coli bacteria swim a manner of managed random walks. Therefore, Free wills of E. Coli bacteria are managed quantum uncertainties.

Because indeterministic decision processes are fundamentally important to survival of all mobile bacteria and animals, through billions of years of evolution, the quantum nature of free will is preserved. Human free wills are a decision-making process taking advantage of indeterministic thermal fluctuations in our brain, which is originated in quantum mechanics.

Built on researches on the free will of E. Coli bacteria, we proposed the central hypothesis of this paper that the free will of a human being is a managed quantum uncertainty. A quantum uncertainty is defined as an indeterministic physical process, which can only be described by quantum mechanics. The word “managed” means that the indeterministic processes are influenced and modified by other physical factors. In other words, human free will is an indeterministic decision-making process, which is managed and influenced by rational and emotional factors. The neural networks of our central nervous systems have learned to magnify and manage microscopic quantum uncertainties of thermal fluctuations to make our minds the most magnificent creations in the universe.

The managed quantum uncertainty hypothesis for human free will is supported by many other circumstantial evidences. Under the isolated and well-controlled laboratory environment, all human behavior should be explainable by fundamental laws of physics, and the initial conditions are always well-defined. In the following, we will contrast the behavior of conscious persons, and unconscious persons to illustrate the nature of human free wills.

1. Unpredictability. Even under the isolated laboratory environment, the behavior of a conscious person is fundamentally unpredictable in a precise way. There is no way to predict what a conscious person will do or say in any precision. In contrast, the behavior of an unconscious person is highly predictable in a precise way. Such unpredictability is a powerful evidence to support the quantum mechanical nature of human free wills.
2. Kolmogorov complexity. The unpredictability of human behavior can be further quantified using the Kolmogorov complexity mathematic machine.

Considering two persons playing the simple rock-paper-scissor game under the isolated laboratory environment, we can construct a data string from the sequence of the moves. For example, RPPS corresponds to an outcome of rock (R) from the first player and paper (P) from the second player in the first round, then an outcome of paper (P) from the first player and scissor (S) from the second player in the second round. The game goes on for a very long time to the Nth round. The experimental result is a very long string of $2N$ characters consisting of the letters R, P, S.

What will be the Kolmogorov complexity of such a data string? Empirical experience tells us: (1) the Kolmogorov complexity of the data string should be close to $2N$ because the data string is essentially random; (2) the complete knowledge of knowing the first N rounds, will not enable us to predict precisely the result of the next $N+1$ round. The empirical experience tells us that the Kolmogorov complexity of the data string of a rock-paper-scissor game can be larger than any finite integer. In other words, the Kolmogorov complexity of such a data string approaches to infinity.

As it turns out, no deterministic physics theory, such as Newtonian physics, deterministic chaos, or general relativity, would not allow the close to infinite

Kolmogorov complexity. Only indeterministic quantum physics would predict the infinite Kolmogorov complexity. Therefore, the human free will must be quantum mechanics in nature. Measurement of Kolmogorov complexity provides a unique way to test experimentally different theories of human free will.

3. Flexibility. A person is cutting a piece of paper arbitrary with scissors at his will under an isolated laboratory environment. Because there is infinite ways for the person to cut a piece a paper, there are infinite possible outcomes.

The implication is that our universe must be infinitely flexibility, and our free wills and our actions are able to reshape the course of our world differently. Any deterministic physics theory would allow only one possible outcome, and there is no flexibility in any deterministic theory.

Let's assume that the person becomes unconscious during the experiment by taking some medicines. Suddenly the infinite flexibility of cutting paper disappears. Because only quantum mechanics would allow the infinite flexibility, the flexibility of human free will must come from quantum mechanics.

4. Fundamental gaps between reasons and choices. A person is asked to do an arithmetic multiple choice of $1+1=?$ with four different choices: 0, 1, 2, 3 under an isolated laboratory environment. While most people probably would choose 2, there are always some people to choose 0, 1, or 3. A person, who chooses 3, might argue that $1+1$ equals to 3 because one husband and one wife could create a family of three. A person, who chooses 0, might argue that he just chooses randomly without any good reason. Therefore, there is a profound gap between the choice and the reason.

The existence of fundamental gaps between reasons and choices are universal phenomena for all decisions. Given several possible choices, no reason can be powerful enough to limit a person's choice. The existence of such gap cannot be explained by any deterministic theory. Therefore, the human free will must be originated from quantum mechanics.

5. Creativity. A person is asked to write an article under an isolated laboratory environment. Humans have the ability to invent things that have not previously existed in nature such as articles, or theory of relativity theory, quantum mechanics, Shakespeare's plays, Mozart's symphonies. If the human free will is governed by deterministic Newtonian physics, one must face a ridiculous conclusion that Shakespearean plays and the theory of relativity are somehow hard wired in our brains.

Although the above discussion is focused on human free wills, these five circumstantial evidences are applicable to free wills of all mobile bacteria and animals. Therefore, the managed quantum uncertainty hypothesis of free will can be tested experimentally. The biochemistry and physiology of the human decision-making process

is one of the most active research areas of neurobiology and so far there is no consensus among biology researchers about their conclusions [26-27].

3.5 The Human Nature and Three Key Concepts of Quantum Politics

In quantum politics, the most important human nature is humans have free wills, and human free wills are quantum phenomena.

In this section, we will clarify three fundamental concepts of political science: freedom, self-control, and quantum uncertainty by applying physics laws of social science and managed quantum uncertainty hypothesis of free wills.

In quantum politics, freedom is defined as actions, expressions, and thoughts at the sole discretion of individual's free will. Because the free will is a managed quantum uncertainty, freedom is essentially managed random expressions of one's free will. On the random aspect of human free will, people are the same as random walks of bacteria and molecules in a fundamental way. While bacteria likes to swim randomly through their environment, humans like to wonder randomly through the world of thoughts and choose to communicate or act upon some of ideas. In the framework of quantum physics, the concept of freedom becomes a precise physics concept. Individual freedom can be quantified with probabilities by applying law of prediction. Law of prediction asserts that the joint probability distribution functions of individual's future actions, expressions, and thoughts are precisely predictable at any moment.

Self-control is defined as the ability to manage individual's free will. For E. Coli bacteria, self-control is the process of regulating the frequency of indeterministic tumbling by stimulus from the external environment. Through billions of years of evolution, humans have perfected our ability to control our own free wills. Humans are no long slaves to our environmental stimulus or our biological instincts and urges. To political science, the significance of self-control is that humans can be hold accountable for their behavior.

Because individual's free will is a quantum uncertainty, the human societies are full of quantum uncertainties. The Law of Indeterminacy asserts that quantum uncertainty is a fundamental property of nature and cannot be overcome by any means. Quantum uncertainties in human societies put a fundamental limit on the ability of any government, political organization, or individual to forecast and control the future of human societies.

Freedom, self-control, and quantum uncertainty are simply three aspects of individual's free wills. Compared the traditional definition for freedom, the definition in quantum politics is narrower and more precise. Applying the law of prediction, the freedom of individuals can be quantified using mathematical probability distributions precisely. Therefore, quantum politics is a precise science, because quantum politics is a branch of applied physics.

In conclusion, the concepts of freedom, self-control, and quantum uncertainty directly lead to many important principles of a free society, like the principle of maximum individual freedom, the principle of voluntary contract, and the principle of fairness. In next section, we will show that these political principles are at foundation of the political system of any free society. Therefore, while they are straightforward aspects of individual's free wills, the concepts of freedom, self-control, and quantum uncertainty are the corner stones of political science.

3.6 Summary of Physics Foundation of Political Science

We have applied PLSS to establish the physics foundation of politics by answering some most important questions of political science: what is the nature of human conflicts? What is the human natural in the new framework of quantum politics? What is the fundamental equation of politics? What is the physics nature of human free will? How to apply PLSS to solve political problems?

After these most fundamental questions of political science are answered with PLSS, we have successfully replaced the traditional political philosophy with quantum physics. Thus the traditional political science has been transformed into quantum politics, which is a branch of quantum physics just like chemistry and optics.

4. The Question: How Should Humanity Govern Itself

In the next few sections, we will apply the framework of quantum politics to solve one of the most difficult and most important problems in all fields of 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, and the much of misery suffered by the humanity today like wars, political oppression, economic crises, hunger, environmental degradation, and extreme poverty are direct results of worldwide poor governing issues. For example, our planet is producing more than enough foods to feed everybody. Yet on one hand, people in many countries are eating too much and are suffering from the obesity epidemics; on the other hand, millions of people today around the world are suffering from hunger and even famine. According to an estimate [28] by Food and Agriculture Organization of the United Nations, approximately one-third of all food produced for human consumption in the world is lost or wasted. The roots of hunger and famine have always been governing issues.

The humanity governing problem is so difficult that the problem remains largely unsolved after works over thousands of years by some greatest thinkers [19-24, 29-46] in the history of humanity: Confucius, Plato, Aristotle, Machiavelli, Locke, Washington, Jefferson, Madison, Kant, Marx, Einstein, Hayek, and many others. While there are great progresses made through experimentations by pioneer politicians and reasoning of political philosophies through ages, there are also epic mistakes made like communism, fascism, Islamism, many wars, and other political movements.

In order to solve the problem, the most important first step is to re-formulate the problem into a question that is answerable by science.

4.1 Scientifically Answerable and Unanswerable Questions in Quantum Politics

As we discussed earlier in the framework of quantum politics, there are two categories of normative political questions. The first category of questions depends on the value-system, and cannot be completely answered by science. The second category of normative political questions can be answered by applying law of equilibrium without using the value system.

The question *what the ideal form of government should be* is NOT answerable completely by science, because the definition of “ideal form of government” depends on people’s value systems. For communists, the ideal form of government is a communism society. For Islamists, the best form of government is a society ruled by Sharia laws. The question *how humanity should govern itself* is also unanswerable completely by science because laws of physics and science do not care how humanity should govern itself.

This paper frames the humanity governing problem in the language of physics: *considering humans as giant molecules with free wills and assuming the humanity is isolated in the universe, what is the most stable political system of the human society?* This question is 100% answerable by science without using the value system.

The most stable structure problems spread widely across all fields of science. For example, the most stable structure of carbon in our daily environment is graphite and the structure of diamond is metastable. The most stable water structure in our daily environment below the freezing temperature is the ice crystal. In nuclear physics, the most stable form of hydrogen isotopes is protium. In biology, most proteins have their own most stable structures. These questions are 100% answerable by science without using the value system through scientific theories and can be verified experimentally.

Therefore, it should not be any surprise to any scientist that the most stable political system problem is completely answerable by science without using the value system.

4.2 The Importance of Boundary Condition

The most stable structure problems highly depend on the environment. In our daily atmospheric pressure, the most stable water structure is the ice crystal below the freezing temperature, liquid water in the room temperature, and the vapor gas above the temperature of the boiling point.

“*Considering humans as giant molecules with free wills*” is a factual statement in order to connect the human society with unanimated molecule systems commonly observed in the condensed matter physics.

“*Assuming the humanity is isolated in the universe*” is a necessary and important condition. The reason is that the humanity equilibrium political state depends on the assumption that only individual persons can have ultimate purposes of life and the human society as a whole over many generations does not have an ultimate purpose. If there was a timeless ultimate purpose, that ultimate purpose would define the structure of the humanity equilibrium political state. For example, if humanity was not isolated in the universe and there were advanced aliens who constantly threaten to kill the humanity or to force the humanity to become their slaves, then the humanity has found an ultimate purpose of resisting and defeating the aliens.

The ultimate purpose for humanity is a key part of the value system itself. When humanity is isolated in the universe as far as we know, we could not establish the ultimate purpose for humanity scientifically from laws of physics.

The humanity in isolation assumption can be weakened substantially without having impacts on the humanity equilibrium political structure. Even if the humanity were not in isolation in the universe, as long as the aliens do not or cannot threaten the

humanity in a significant way, the humanity still cannot establish an ultimate purpose scientifically.

Even if the humanity does find a collective purpose temporary, it would only impact the temporary political structure and has no impact on the long-term equilibrium political state.

So far we have formulate the governing problem for the entire humanity. However, because the humanity in isolation assumption can be weakened substantially, the equilibrium political structure theory is also applicable to individual countries and individual political organizations. The key issue is whether there is an ultimate purpose for individual countries or even individual political organizations. For example, corporations have a well-defined purpose of maximizing the wealth of share-holders. It will have a very different political structure than governing a country.

5. The Answer: Equilibrium Political Structure and Permanent World Peace

In this long section, we will derive the equilibrium political structure through an analog with the hard rod system in the condensed matter physics. The equilibrium political structure is characterized by a set of 16 democratic principles. We will discuss each of 16 democratic principles in detail.

5.1 Nash Equilibrium

The equilibrium political structure is a Nash equilibrium. In politics, every individual tries to maximize his or her own political power and also is willing to compromise. The final result of the compromise corresponds to the Nash equilibrium political structure [16].

However, it is difficult to gain the further insights about the structure of the Nash political equilibrium state through the game theory approach.

In order to gain the deeper insight of the equilibrium political structure, we need the law of equilibrium and the equivalent relationships between the human political system and the hard rod system in the condensed matter physics.

5.2 Law of Equilibrium

As we discussed earlier, the most stable structure problems are common across all fields of science like the condensed matter physics, chemistry, biology, nuclear physics, and much more. As long as the quantum indeterminacy plays a role in the system, the equilibrium state is governed by law of equilibrium. In deterministic classical Newtonian physics, the stability of the systems are often defined by the governing differential equations. Because everything is deterministic, the effect of a small perturbation is exactly predictable. The equilibrium state is not very well defined in a deterministic system. However, if the small perturbation is indeterministic, the equilibrium state is well defined by law of equilibrium. In quantum systems including all thermodynamic systems, the ground states are the ultimate equilibrium state; if the systems are excited and stable through the interaction with the environment, the equilibrium state is well defined by law of equilibrium. In short, law of equilibrium is a generalization of the second law of

thermodynamics, and broadly applicable in all fields of science. Thus, it is no surprising that the political equilibrium state is also governed by law of equilibrium.

Law of equilibrium essentially guarantees the existence of an equilibrium political state of humanity. As long as it exists, we could find many ways to figure out the detailed structure.

5.3 The Equivalent Principle

In this section, we discuss the equivalent relationships between the human political system and the hard rod system in the condensed matter physics.

5.3.1 Hard Rod System in Condensed Matter Physics

The hard rod system [47-51] is a system consisting of microscopic identical hard rods. The hard rod system is extensively studied as the simplest model system of the liquid crystal [52] in the condensed matter physics. Theoretically, the hard rod system is simple enough to be studied experimentally [47], mathematically [48], and by the computer simulation [50]. In statistical physics, the hard rod system can be described by the principle of maximization of entropy. Experimentally [47, 51], the tobacco mosaic virus solution is an ideal system that can be described well by the hard rod system because viruses are all the same size and the dominant interaction between virus particles are the hard core exclusion force.

The most striking behavior of the hard rod system is the amazing display of different phases [47]. When the concentration of the hard rod increases, the system changes spontaneously from isotropic phase to nematic, smectic A, and crystal phases. *The equilibrium state of the hard rod system can be simply described [49] as individual hard rods to achieve the maximizing of individual freedom by compromising with their neighbors.* Onsager [48] was the first person to describe the isotropic to nematic phase transition as the compromising the orientation of freedom in order to achieve more translational freedom.

As we will discuss in more details in the following sections, *the essence of the equilibrium political state of human society can be precisely described as individual free wills to achieve the maximization of individual freedom by comprising with other individuals through voluntary social contracts.* Since the equilibrium state of the hard rod system has been well established in the condensed matter physics and little is known about the equilibrium political state of the human society, the hard rod system serves as an excellent guidance to the study of quantum politics.

5.3.2 Human as Giant Molecule with Free Will

Human being is often called different things by scientists from different perspectives. To chemists, human being is just a biochemical reactor. To nematode worm biologists, human being can be simplified as a giant worm due to the similarity in the underlining biology. To fruit fly biologists, human has been called a walking fruit fly.

To quantum physicists, a human being is most accurately called as a giant molecule with free will and the human free will is a quantum phenomenon.

5.3.3 Interactions between Individual Free Wills

In the condensed matter physics, the most basic question is always about the forces and interactions between individual molecules. In a human society, the interactions of free wills can be captured by maximization of individual freedom, conflicts, and the resolution of the conflicts.

In a hard rod system like the tobacco mosaic virus solution, the individual virus particle is randomly walking indeterministically. The dominant interaction between virus particles is the mutually exclusion from occupying the same physical space. In water solutions, the tobacco mosaic virus surfaces are negatively charged and the electric repulsion forces between virus particles make the exclusion volumes bigger than the size of individual virus.

In a human society, the behavior of human free wills can be captured by the indeterminacy, freedom, and self-control as we discussed in earlier sections. If one does whatever one wishes in an indeterministic way, the individual freedom of choice is maximized. The only constraint would be the surrounding environment. However, generally speaking, people are not living alone and cannot be allowed to do whatever one wishes because of the existence of other individuals. When multiple free wills have conflicting visions of the future, laws of physics would not allow the conflicting visions of the future to become reality.

The default resolution of the conflicts of free wills is through violent fights as evident from the empirical observations of young kids in preschools and animals in the nature environment. It is unique for the human beings to resolve the conflicts of free wills mainly through reasoning and compromise.

The resolution of the conflicts of free wills can be classified by the degree of violence involved. On one the extremely violent end of the spectrum, people could murder each other in order to get they want. On the other end of the spectrum is the nonviolence resolution. The nonviolence resolution can be further classified according to the degree of selfishness involved. On one the end of the spectrum, people will demand and fight for the maximum degree of political power and other interests for themselves; on the other end of the spectrum, people are completely selfless and perfectly willing to give up their own power and interests.

This paper asserts that there is an important stable fix point among the whole spectrum of human choices, where people would fight for the maximum of political power and other interests for themselves through the compromise in a nonviolent manner.

5.3.4 Human Society as a Physical System of Conflicting Free Wills

Considering the human being as a giant molecule with the free will, the human society of conflicting free wills is not very different from the hard rod system like tobacco mosaic virus solutions. The interactions among human being are mainly through exchanging information. From the politics point of view, each human being is trying to maximize their freedom of choices until their visions of the future run into the conflicts of other human beings.

One key insight of this paper is that the freedom of individuals is actually maximized by entering the voluntary social contracts. Essentially by paying a small price of exercising the self-control of their free wills to obey the voluntary social contracts, individuals gain the personal safety guarantee and more freedom of choices.

One good example is the social contract of traffic rules. In a busy place like New York City, few people, cars, and buses can go anywhere and the city would be completely dead-locked without the traffic rules. By paying a small price of obeying the traffic rules, New York City residents gain the personal safety by avoiding traffic accidents and more freedom to move around the city in a much easier manner. The traffic rules are created by traffic experts and the elected leaders representing the interests of city residents.

Amazingly, the same dynamics happens in tobacco mosaic virus solutions. Onsager [48] first pointed out that when the virus concentration is high enough to form nematic phases, individual viruses would pay a small price by limiting their rotation freedom to maximize their translational freedom. Otherwise, virus particles would be deadlocked and few viruses could move around freely. Because we understand the physics of tobacco mosaic virus solutions extremely well, we can apply the same physics principles to solve the humanity governing problems.

5.3.5 Equivalent Relationships in the Condensed Matter Physics

One remarkable discovery in the condensed matter physics in recent decades is the developments of equivalent relationships between very different physical systems.

One good example is the analogy between the TGB liquid crystal phases and the superconducting metals [52-53]. In 1972, Pierre G. de Gennes suggested [54] that there is a phenomenological analogy between the nematic/smectic phase transitions in liquid crystals and the normally-conducting/superconducting in metals. Based on this analogy, he predicted the existence of the regular defect structures in smectic liquid crystals with the analog of the mixed states in the type II superconductors. In 1988, Renn and Lubensky [55] extended the de Gennes analog to the chiral liquid crystals and predicted the TGB phases. In 1989, Goodby and colleagues [56] synthesized a chemical called 14P1M7, the compound was first used for the experimental confirmations of the existence of TBG phases.

Thus, despite the apparent difference between the TGB phase liquid crystals and the type II superconductor metals, the collective behavior of two systems are governed by a very similar set of principles and a few key system variables.

5.3.6 Equivalent Relationships between Human Society and Hard Rod System

The most important insight of this paper is that the many-body problems of a human society are equivalent to the many-body problems in the hard rod system. Since we know very little about the collective behavior of the human society and know a great deal about the hard rod systems, in essence, we can use the hard rod system like tobacco mosaic virus solutions as a road map to discuss the equilibrium political structure,

hydrodynamic fluctuations, metastable structures, and the system dynamics in the human society.

Researches in the condensed matter physics over many decades [53] have shown that despite the apparent complexity of the condensed matter systems, the key collective behavior like the equilibrium states, phase transitions, hydrodynamic fluctuations, and the system dynamics of many-body systems are mainly determined by a handful principles and a few key variables like the symmetry, dimensionality, boundary conditions, and conservation laws.

In the following, we compare side-by-side the human society to the hard rod system exemplified by the tobacco mosaic virus solutions in order to show the equivalent relationships as well as the difference of two systems.

(1) Size. A typical human is from about 0.2 meters tall (babies) to 2 meters (giants like professional basketball players). A tobacco mosaic virus has a cylindrical shape with the length of 300 nm (nano-meters) and a diameter of 18 nm. Atoms and small molecules like water are typically about 0.1 nm to 1nm.

(2) Time Scale. The relevant time scale is the time span between collisions or interactions. Humans are interacting with each other ranging from a few seconds to days and years. Macromolecules like tobacco mosaic viruses collide with each other at the time scale of micro-seconds. Atoms and small molecules like water collide with each other at the time scale of 0.01 nanoseconds.

The difference of time scale determines the time span needed to reach the equilibrium state. It will take about a few days for the tobacco mosaic virus solution to reach the equilibrium state while it could take about 10,000 years for the human society to reach the political equilibrium state spontaneously.

(3) Interaction. Any physicist would agree that interactions between individuals are always the key in understanding the collective behavior of many individuals. Humans interact with each other mainly through the exchange of information. Interactions between macromolecules are the mutual exclusion of the same physical space. The interactions between atoms and small molecules like water are electromagnetic forces. Thus interactions between humans are rather unique comparing to physical and biological systems.

(4) Population. The existing human population on the earth is about 7 billion people. A drop of tobacco mosaic virus solution has about a few trillion virus particles. The number of atoms and small molecules are often measured by the Avogadro constants.

(5) Governing Physics Laws. The human society, tobacco mosaic virus solution, and small molecules like water all obey the same physics laws of social science. The law of equilibrium is the generalized second law of thermodynamics.

(6) Governing Physics Principles near the Equilibrium State. Applying the three thermodynamic laws and principles of statistical physics to the tobacco mosaic virus

solutions near the equilibrium state, the governing physics laws can be simplified [47]. Because there is no internal energy involved in the partition function, the minimum Helmholtz free energy principle of the canonical ensembles is reduced to the principle of the maximum entropy. Thus, in the layman term, the most important physics principle for the tobacco mosaic virus solution is that the system will spontaneously organize itself by maximizing the freedom of movement of individual virus particles through compromising with their neighbors.

Applying the equivalent relationships between the human society and the hard rod system, this paper proposes that the most important physics principle for the human society near the equilibrium state must be the principle of the maximization of individual freedom of choices through compromising with other individuals. When the human society reaches the maximization of freedom, the human society of conflicting free wills reaches the equilibrium political state.

(7) Symmetry of the Equilibrium State. In the condensed matter physics, the equilibrium states are often highly symmetric structures. For the tobacco mosaic virus solution, the equilibrium states of isotropic, nematic, smectic A, and crystalline phases are characterized by their different symmetries.

Applying again the equivalent relationships between the human society and the hard rod system, this paper proposes that the equilibrium political state is characterized by the principle of political equality or the exchange symmetry between individual free wills. In other words, individual free wills enjoy the same amount political rights.

By definition, all equilibrium states are timeless and have the time translational symmetry.

(8) Hydrodynamic Modes and Fluctuations in the Equilibrium State. In the condensed matter physics, the equilibrium state is not static. For example, the water molecules would vibrate around the equilibrium positions in an ice crystal. There are generally two types of fluctuations: short-term transient fluctuations and low frequency long lasting hydrodynamic modes. The hydrodynamic modes are often called Goldstone bosons. In the ice crystals, the hydrodynamic modes are often called the phonons, which play important roles in many physical dynamic processes.

For the TMV solutions, the fluctuations of the equilibrium state are characterized by a few hydrodynamic modes [47] related to symmetric breaking and conservation laws. For example, the fluctuations in the nematic TMV solutions are characterized by the director field fluctuations, the virus density fluctuations due to the mass conservation laws, and the pre-transitional smectic A density fluctuations.

Applying again the equivalent relationships between the human society and the hard rod system, this paper proposes that there are many hydrodynamic modes in the equilibrium political state. These hydrodynamic modes are called democratic principles. We will describe these democratic principles in the next section in greater details. Like other condensed matter physics, these hydrodynamic modes play key roles in the dynamics of the human society.

(9) Dynamics and Social Changes. Humans have free wills, and humans keep trying to invent new things and new ideas. Human free wills drive the society changes.

Likewise, the random walk of TMV particles drives the solution physical changes. The collective behavior of social changes is captured by hydrodynamic modes in both the hard rod system and the human society.

(10) Phase transitions. Phase transitions are most dramatic phenomena in the condensed matter physics. For example, liquid water is frozen into ice. There are many interesting phase transitions between different equilibrium states in TMV solutions like isotropic to nematic, nematic to smectic-A, smectic-A to crystalline phase transitions when the virus concentration changes.

In the human society, when the human population was very small and there were very limited interactions beyond their neighbors, the human society mainly existed in the tribal state. When the human population increases, different political states started to appear. While the human society has only one equilibrium state in the distant future, there are many metastable states like monarchy, aristocracy, and limited democracy. Thus it is possible to observe the phase transitions between meta-stable states in the human society. The fall of socialist governments in the Eastern Europe in 1990s can be characterized as the phase transition between two different metastable states.

To summarize, the behavior of the human society and the hard rod system is very similar. Therefore, the equivalence relationships between these two systems can serve as the useful road map for studying the equilibrium political state of the human society.

5.4 Structure of Equilibrium Political State and Democratic Principles

In previous sections, we have taken advantage of the equivalence relationships between the human society and the hard rod system to gain a clear idea the overall structure of the equilibrium political state. However, there is a limitation to the approach. The details of the equilibrium political state of the human society must come from the long-term causality relationships in the human society.

In this long section, we present the structure of equilibrium political state through the internal logics of the human society and the physics laws of social science. The equilibrium structure is characterized by a set of 16 democratic principles. Some of these democratic principles are new to political science while other principles are well-known to political science. Once the old principles become parts of the quantum politics, they become precisely defined as physics concepts satisfying the high standard of a physics model.

5.4.1 Principle of Maximum Freedom

Just like the equilibrium state in the hard rod system is characterized by the maximization of entropy, the most important feature of the equilibrium political structure is characterized by the maximization of the freedom of the human society.

The principle of maximum freedom says that a society should give citizens the maximum freedom to making choices. The human beings love freedom of choices, and the maximum freedom will push the economy toward the most efficient state and bring out the maximum creativities in fields of science, technology, and arts according to the law of equilibrium.

One contribution of this paper is that it gives a precise physics definition of the concept freedom. In quantum politics, freedom means freedom of making choices. This definition is inconsistent with the concept of negative freedom in the traditional political science.

5.4.2 Principle of Nonviolence and Voluntary Contract

When each individual attempts to maximize their freedom of choices, it will soon run into the conflicts with other individuals because the fundamental limitations of physics laws. The maximization of freedom is true for human, animals, and unanimated TMV virus particles. One resolution of conflicting free wills is through compromise. What set the human being apart from animals and TMV particles is our ability to resolve the conflicts of free wills peacefully and even permanently through the voluntary contracts.

The principle of nonviolence and voluntary contract consists of the principle of nonviolence and the principle of voluntary contracts. The principle of nonviolence says that a society should resolve all conflicts among human free wills in a nonviolence manner. The principle of voluntary contracts is to restrain free wills without harming the individuals' freedom by asking citizens to be held accountable only for voluntary contracts agreed upon by themselves or through their representatives.

5.4.2.1 Concept of Mature Society

One important concept of quantum politics is the concept of a mature society. A mature society is a human society that embraces the principle of nonviolence to resolve all conflicts between human free wills in a nonviolence manner.

The principle of nonviolence should be one of the most important principles to be embraced by all people and governments around the world. Unfortunately, after 200,000 years since the dawn of the humanity, the human society has been very slow to brace the principle of nonviolence.

Look at the world today. Inside many countries with the long and mature democratic tradition, the principle of nonviolence is almost fully embraced. For example, in US, virtually all conflicts between human free wills can be resolved peacefully through in nonviolence ways. According to a report by the United Nation Office of Drugs and Crime, Japan and many European countries homicide rates are below 1 in 100,000 a year. Therefore, the principle of nonviolence is the reality and not an unrealistic ideal.

In non-democratic countries, the governments generally rule the population with the implied threat of violence for any one dares to challenge the governments. Thus these non-democratic governments fundamentally reject the principle of nonviolence.

In countries with the weak democratic tradition, although the government might embrace the principle of nonviolence, and some people in the general public are not ready to give up the old habits of settling the difference with violence. For example, while Mexico is a democratic country, the gang violence in Mexico is almost epidemic. According to a report [57] by the United Nation Office of Drugs and Crime, the homicide rate in Mexico in 2013 is 22 per 100,000.

In terms of the international relationships around the world, using the principle of nonviolence to resolve conflicts between countries is only embraced by a few of democratic countries. In reality, most big countries including US, India, China, Iran, Japan, and Russia are devoting huge resources to upgrade their military capabilities to be ready for next major wars.

Therefore, as of today, the human society is still far from a mature society to resolve our conflicts through peaceful means. However, there should be no doubt that the human society is heading towards that direction.

5.4.2.3 Permanent Peace and Not Temporary Peace

The nature of politics is the resolution of conflicts of human free wills. There are relatively easier to achieve the temporary peace through temporary measures. However, in order to achieve the permanent peace among conflicting free wills, a stable logical conflict resolution system, which must be fair to all parties, must be carefully designed. Constitutions of many democratic countries are essentially carefully designed stable legal system for the conflict resolution. The equilibrium political system defined by law of equilibrium is essentially a stable logic system for the resolution of conflicting human free wills.

Take a fair division of a cake by two identical twin brothers as a simple example. Because each of brothers wants a bigger piece of the cake for himself, the conflicts are inevitable. The question is how you would resolve the conflicts. There are many ways to achieve the temporary peace like moral persuasions. However, moral persuasions could only work a few times. After that, the fighting resumes. In order to achieve a permanent peace, it takes a lot more than temporary measures like moral persuasions. A fair division conflict resolution system must be designed. For example, the person who cuts the cake must let the other person to choose first. If money is involved, divide the cake into a few pieces and then auction off all the pieces would ensure the most efficient allocation of a scarce resource through the free trade mechanism.

In order to for the whole human society to embrace the principle of nonviolence principle, the temporary measures like moral persuasions are far from enough. In history, many culture and religious leaders including Confucius, Jesus and Buddha has been preaching messages of respect, love, and mercy for more than 2,000 years. Yet the wars and violence have continued up to now.

In conclusion, for the human society, the rules to achieve the permanent peace are very different from the methods to achieve the temporary peace. This paper proposes that the permanent world peace can be only achieved through the careful designing the voluntary social contracts to reflects the deepest nature of humanity and PLSS.

5.4.2.4 Principle of Voluntary Contract

In human society, maximum freedom does not mean unlimited freedom. Unlimited freedom will make everyone a violent criminal. The key to restrain free wills without harming the individual's freedom is to ask citizens to respect and be held accountable for voluntary contracts agreed upon by themselves.

Unlimited freedom is dangerous. A typical two-year-old toddler does not have much self-control but he or she does have free wills. A toddler would eat anything he or she could reach, and even touch fire and electrical outlets. Toddlers are so dangerous that an adult has to watch out for them all the time. It is a good thing that they are small, slow, weak, and do not have many fancy needs.

For grow-ups, some kings, emperors and queens and their family members have essentially unlimited freedom. Unlimited freedom transformed many rulers into dangerous monsters. According to historic records, one ancient emperor in China became the supreme leader at sixteen years old. He completely indulged himself in sex and wine for nearly two years, and died at the young age of eighteen. Unlimited freedom killed this undisciplined emperor. In recent years, two sons of Saddam Hussein were infamous for their brutal crimes. Because of the absolute power of his father, Uday Hussein had essentially unlimited freedom in Iraq. Uday once stabbed to death one of his father's bodyguard at a high society party in full view of hundreds of guests in 1988. As the head of the Iraq Olympic Committee, he tortured athletes who failed to meet his expectation at will. Uday Hussein was a vivid example of a violent monster with essentially unlimited freedom.

In a long and difficult path toward the principle of the rule of law, the Magna Carta of 1215 A.D. was an agreement widely recognized as a historic milestone which required the free will of the king of England to be bound by law. Fed up by abuses of King John in 1215 A.D., with help of the Pope, rebel English nobles asked King John to sign the agreement (Magna Carta) to recognize rights for both noble and ordinary Englishmen. No one, including the king, is above the law. Today clauses 39 and 40 of the Magna Carta remain valid law in England. Clause 40 promises to no one will we sell, to no one will we deny or delay right or justice. This clause establishes the principle of equal access to the courts for all citizens. Clause 39 promises that no free man shall be taken, or imprisoned, or deprived of his property, or outlawed, or exiled, or in any way destroyed, nor will we go or send against him, except by the lawful judgment of his peers or by the law of the land. This clause establishes the jury system, requires that the king would follow legal procedures before he punished someone, and not to punish anyone at his own free will.

There are voluntary and involuntary ways to restrain people's free will. Involuntary ways include being forced to agree under threats of violence. Voluntary ways are to choose to agree at one's free will without any external coercive pressure. As it turns out, only voluntary contracts are needed to create the rule of law and a free society. The principle of voluntary contracts says that in a free society, citizens are required to obey or be held accountable to any outcome of a voluntary contract. A human being has a remarkable ability and willingness to accept any outcome of a voluntary contract without feeling unjust or in violation of one's free will. Animals like chimpanzees have free wills but have not developed enough to understand the concept of voluntary contracts. Most voluntary contracts involve quantum uncertainties in the future. Since no one is able to overcome the quantum uncertainties in the future, voluntary contracts are fundamentally fair because parties reach agreements at their own free wills.

Laws and rules made by freely elected legislators and officials are considered voluntary contracts of citizens, because a citizen is free to choose their political representatives and officials at one's own free will. However, any law, including the

constitution, must allow the flexibility to be modified by the collective free wills of its citizens. No rule in a free society is so sacred that it cannot be modified by the collective free will.

To summarize, this paper has shown that the world can achieve the permanent world peace, the maximum freedom of choices, and pursuing maximum individual's interests simple by restraining the free wills through social and private voluntary contracts without resorting to any moral persuasion.

5.4.2.5 Concept of National Permanent Peace

The concept of national permanent peace is the combination of the principle of nonviolence, the concept of a mature society, the concept of permanent peace not temporary peace, and the principle of voluntary contract. In essence, within a national border, the national permanent peace can be achieved through a well-designed constitution based on the principle of voluntary contracts in a mature society.

Since a mature society is a human society that embraces the principle of nonviolence to resolve all conflicts between human free wills in a nonviolence manner, the principle of nonviolence could be codified through a constitution based on the voluntary contracts. The result is the national permanent peace.

While the permanent world peace is a remote dream of humanity, this paper points out that it is very important to realize that the humanity has almost achieved the national permanent peace in many mature democratic countries. We emphasize "almost achieved" because in order to achieve the true national permanent peace, the constitution must be carefully designed without fundamental design flaws, and most today's constitutions include the constitution of US have many fundamental design flaws.

For example, in the United States, nearly all conflicts of free wills are expected by citizens to be resolved through negotiations, voluntary contracts, elections, political, legal, and other peaceful means. Since the constitution was created in 1787, the American society has enjoyed 227 years of stable continuous governments and relatively internal peace, with several major exceptions like the Civil War and American-Indian Wars. The occurrence of the Civil War and American Indian Wars reveals that there are fundamental design flaws of the original constitution.

In following sections, this paper shows that the political equilibrium state is a legal structure without fundamental design flaws.

5.4.3 Logic Framework of Political Equilibrium State

In a hard rod system, the logic framework of the thermodynamic equilibrium state is the maximization of freedom or entropy through compromising.

In the human society, the logic framework of the political equilibrium state is the principle of maximum freedom and the principle of nonviolence and voluntary contract. There are many other democratic principles like equality and the rule of laws can be simply regarded as parts of the carefully-designed social voluntary contracts in the equilibrium state.

The principle of maximum freedom provides the maximum freedom of choices to citizens and limits the government's laws and regulations to an absolute minimum. The

principle of nonviolence and voluntary contract provides a valid and peaceful mechanism to restrain free will without harming severely anyone's freedom. Principle of voluntary contracts also provides a political foundation for a free economy, which is the most efficient in allocating society's scarce resources. Principle of voluntary contract asks government to respect private voluntary contracts as long as private contracts do not violate laws and regulations.

In the next few sections, we will discuss the main principles of carefully-designed social voluntary contracts in the equilibrium political state.

5.4.4 Accountability Test and Principle of Political Equality

The accountable citizen test is designed to tell whether a citizen can be held fully accountable for his or her choices and voluntary contracts. With the exception of underage children and people with mental disability, nearly all people in a human society are accountable citizens. The principle of political equality says that all accountable citizens must have equal political rights.

Animals cannot pass the accountability test. Therefore, they will not be equal citizens of the human society.

The principle of political equality demonstrates that the equilibrium political state has the exchange symmetry among accountable citizens. As we discussed earlier, most equilibrium states in the condensed matter physics have symmetries. The exchange symmetry means that politically anybody can be replaced by others without changing the structure of the equilibrium political state.

There are still many discussions around the world about who should be eligible to vote in a democratic election. The accountability test and the principle of political equality answer this fundamental question in a concise way that the eligible voters are citizens who can be held fully accountable for his or her voluntary contracts. The gender, race, or the different levels of wealth and education are not fundamentally important.

Because many failed experiments of democracy around the world, there is still much confusion whether it exist some political economic or social criteria that a human society must meet in order to be ready for the democracy. The answer given by the accountability test and the principle of political equality is clearly no. The economic development, educational levels, culture, history, or religious traditions of a society are not fundamentally important.

Whether a society embraces the principle of nonviolence and voluntary contract is fundamentally important. Many experiments of democracy have failed precisely because some political forces embraced violence as ways to settle political difference and refused to obey the laws and the constitutions.

5.4.5 Principle of the Rule of Law

The principle of the rule of law means that the behavior of government and all accountable citizens are restrained and only restrained by voluntary contracts to safeguard against any arbitrary ruling of any authority in the society. The principle of the rule of law guarantees that voluntary contracts will be enforced. Without the rule of law, a free society would be in chaos. Principle of the rule of law is one of the most important

principles of a free society, and effectively grants the justice system the power to punish lawbreakers. In a peaceful society, only the government should have the power to punish a citizen with violence.

While the principle of the rule of law is universally accepted by people around the world, unfortunately, many governments are willing to pay only the lip service. Official corruption is a huge problem in many developing countries. Principle of the rule of law requires the justice system to punish those corrupted officials without mercy. With a weak legal system, the economy cannot achieve its true potentials because contracts are not always enforced. Most importantly, a society is not truly free if coercive and corrupted forces are allowed to run wildly. The principle of the rule of law guarantees that voluntary contracts will be enforced.

5.4.6 Principle of Separation of Power

In the equilibrium political state, the collective power is coming from voluntary contracts of equal citizens. One nature consequence is that the political power is more distributed in the society in contrast to the concentration of political power in one or a few people in other forms of governments like authoritarianism and totalitarianism.

The principle of separation of power is well understood and established in a mature democracy like the US governments. The three branches of federal governments are more or less functioning well together through countless crises like wars, recessions, depressions, impeachments, and political movements. While the US president is often called the most powerful person in the world, officially he is merely the head of the executive branch of the federal government and his power domestically is very limited. The relationships between the president and governors of states are political partners rather than subordinates.

While there are constantly struggles for the power grabbing among three branches of federal governments, or between the federal and state governments, the flexibility of distribution of political power is one of essential pre-requests for the optimal decision making in the political equilibrium states.

5.4.7 Principle of Check and Balance

The principle of check and balance is needed because the law of prediction says that we cannot predict how elected officials will behave. Strong institutional check and balance are essential to minimize probabilities that elected officials would abuse their powers.

In ancient England, and many other countries, the legal principle was the king or emperor can do no wrong. He was above the law and people. Removing a king means a bloody business of civil wars. Unlimited freedom transformed many emperors and kings from ordinary people into murderous criminals. Absolute power was bad for people and also bad for kings and emperors.

The government in a free society is endowed great powers by citizens. The question is how to make sure these powerful government officials, lawmakers, and judges will not abuse their power.

According to the law of prediction of PLSS, we cannot predict precisely how elected officials will behave because they have free wills. Besides asking elected officials to sign voluntary contracts to agree to behave, the law of choice says that there are needs to have strong institutional checks and balances to minimize probabilities that elected officials would abuse their powers.

The principle of checks and balances says that powers of elected officials must be checked and balanced. The principle of checks and balances means that the punishment promised by the law might not be enough to prevent the abuse of the power, and institutional checks and balances take away powers from officials to reduce their opportunities to abuse powers.

In the US, the power of the federal government is divided into three branches: legislative, executive, and judicial branches. The constitutional framers let the powers of these three equal branches check each other.

The principle of checks and balances is well understood in mature western democratic countries, which enjoy relatively low official corruptions. However, in many developing countries, official corruptions are epidemic because of lack of respect to the rule of law and weak institutional checks and balances.

5.4.8 Principle of Optimal Decision Making

The central topic of politics is how to solve the social problems collectively. The political equilibrium state corresponds to establishing the optimal decision making process.

The political decision making has been extensively studied as a cross fertilization between economics and political science. The area of study is known as public choice theory [37]. While the theory and practice of the political decision making in quantum politics shares many conclusions from the public choice theory, the key difference is summarized as the following:

- (1) In quantum politics, political decision making consists of distinct two parts: the scientific part which forecasts the consequence of public policies in the language of probability, and the value system part which evaluates the probabilistic consequences. Quantum politics emphasizes the value-free scientific forecasting part of decision making processes.
- (2) Quantum politics emphasizes that the political equilibrium state can achieve the optimal political decision making because of the flexibility offered through constitutional democracies in terms of where who how to make collective decisions. The flexibility of separation of political power is one of essential pre-requests for the optimal decision making. The other pre-requests includes the flexibility to offer the political decisions to be made through a broad range of methods: referendum, the voluntary process of the free markets, a group of representatives, a group of experts, or a pointed decision maker acting like a dictator with limited mandates or a military commander. The decision process in the political equilibrium state is fundamentally fair to

all parties including majority, minority, children, the future generations, foreigners, aliens, animals, and other objects with free wills.

- (3) While quantum politics shares emphasizes the fundamental roles of individual rights, personal religions, philosophies, and value systems in the collective decision making processes because of the impossibility of establishing scientifically the ultimate purpose for the society and a value system for the society. The clear goals and the value systems are essential to evaluate different options in the collective decision making processes. The individuals can have their own ultimate purposes and the value systems because individuals have free wills. However, we cannot establish scientifically the ultimate goal and the value systems for the society because of physics laws of social science. Mathematically, Arrow's impossibility theorem [58] shows the difficulties in ranking the social preference.
- (4) Quantum politics also emphasizes the importance of separating the church and state. Although the ultimate purpose and the value system of the society cannot be established scientifically, it can be established through establishing the official religion. It would lead the society away from the equilibrium political state.
- (5) Quantum politics share with the public choice theory about the importance of the conflicts of interests of politicians. Quantum politics emphasizes the fiduciary duty of the decision makers to general public, minority, woman, children, the future generations, animals, plants, and the natural environment in general.

Therefore, the principle of optimal decision making is to optimize the collective decision making processes through scientific forecasting, separation of power, balancing interests of all parties involved, carefully choosing the goals and value systems by balancing the science, religion, and political philosophies, and choosing the decision making methods.

5.4.8.1 Principle of Individual Rights and Fiduciary Duty

The principle of Individual Rights and Fiduciary duty reflects the relationships between the collective decision makers and all parties involved.

Principle of individual rights says individuals have certain basic rights that cannot be taken away by the government. The principle of individual rights is well understood in a mature democratic society.

The principle of fiduciary duty says that the decision makers have fiduciary duty to guard interests of other citizens including minority, woman, children, the unborn future generations, foreigners, animals, other living creatures, and the environment in general.

Fiduciary duty is a basic relationship of trust between two parties. The trustee has legal duties to look after the best interest of other parties. In the case of no conflicting interests, the trustee should exercise his or her best judgment and the best effort to look

after the other party's interests. In the case of conflicting interest between trustee and the other party, the trustee should follow some conflict resolving rules. In a modern society, fiduciary duty exists between specialists and clients. For example, physicians have fiduciary duty to their patients. Physicians are not allowed to take advantage of ignorance of medical knowledge of patients for their own benefits. Stock brokers and investment professionals are required by law to have fiduciary duty to their clients. It is illegal to take advantage of clients' ignorance of financial markets. In the case of conflicting interests, stock brokers and investment professionals must disclose the conflicts of interests to their clients.

In politics, elected representatives and government officials owe fiduciary duty to their citizens. The majority of accountable citizens have fiduciary duty to the minority citizens. The majority cannot be a majority tyrant and abuse their majority position to pass laws to abuse the minority.

While animals like chimpanzees and dogs cannot vote, they do have certain constitutional rights. Principle of fiduciary duty unambiguously says that it is the voting citizens' fiduciary duty to look after the best interests of non-voting citizens, which includes animals, plants, and other living creatures. Without addressing the relationship between accountable citizens and non-voting citizens and other living creatures, the constitution is fundamentally flawed. Any living creatures like bacteria in a human society have certain constitutional rights.

Regarding the future generation, the political equilibrium state has the time translational symmetry. In essence, the political equilibrium state requires that no generation should be allowed to take advantage of the future generations. In terms of the wealth transfer between different generations, the time translational symmetry implies that there must be no net wealth transfer between generations, and only the knowledge of science and technology will pass on to the future generation and continue to accumulate. In terms of environment, each generation has fiduciary duty to protect the environment for the benefits of the future generation.

The political equilibrium state sets a very high standard for the collective decision makers to exercise their fiduciary duties in order to make decision processes fair to all parties involved.

5.4.8.2 Principle of No Scientific Ultimate Purpose

The principle of no scientific ultimate purpose has two meaning. At the personal level of individuals, it means that science cannot provide 100% justification of personal choice of the ultimate purpose of the life. Science could only go as far as saying that the personal choice of the ultimate purpose has predictable consequences in the future based on physics laws of social science. However, the consequences alone are not sufficient to justify the choice of the ultimate purpose of life. In the end, the personal choice of the ultimate purpose could come from personal religions, philosophies, or anywhere else. Also individuals could change their choices of the life's ultimate purpose at any moment.

At the social level, it means that the society does not have an ultimate purpose that could be justified by science. Regarding the ultimate purpose, individuals are sovereign and supreme. Individuals can have personal ultimate purpose of the life. The

society does not have the ultimate purpose. If the government forces any ultimate purpose on individuals, it leads the society on the road to serfdom.

One key principle of the political equilibrium state is the principle of no scientific ultimate purpose. Quantum politics is physics and physics cannot provide the scientific ultimate purpose for individuals and the society. However, the decision making process often needs to set the goals. While setting different goals has scientifically forecastable consequences, science alone cannot set the goals. Therefore, there is a void created by the fundamental limitation of laws of physics.

That void must be filled with something. Therefore, in quantum politics, in terms of the decision making, the science and personal religions/philosophies are surprisingly equal partners.

In quantum politics, science and religion/philosophy have strange harmonic relationships. Each of them plays a fundamentally important role in the decision making process.

If there were a scientific and universal ultimate purpose of humanity, all political decisions would be evaluated based that ultimate purpose. It would soon lead the human society into a dark road to serfdom, where individual freedom and individual rights do not matter. It is a good thing that the equilibrium political state has no scientific ultimate purpose.

Historically many political leaders attempted to impose their personal views of the ultimate purpose to the society like communism, Islamism, fascism, and nationalism. The results were always disastrous.

Individuals can set their own personal ultimate purpose, and they also can change the ultimate purpose all the time because they have free wills. However, the society must have no collective ultimate purpose.

The permanent world peace can be chosen as the ultimate purpose by individuals. However, it is not the ultimate purpose of the human society. The permanent world peace is spontaneous orders rising from countless individual choices. In the hard rod system like tobacco mosaic virus solutions, the collective spontaneous orders rise from the random walks of individual virus particles.

The maximum freedom can also be chosen as the ultimate purpose by individuals. However, it is not the ultimate purpose of the human society. If the maximum freedom is chosen as the ultimate purpose of a society, everything else in the society would become secondary. However, on the individual level, while freedom is something people do value, it is certainly not the most important thing in everyone's life all the time.

The maximum wealth can also be chosen as the ultimate purpose by individuals. However, it is not the ultimate purpose of the human society. If the maximum wealth is chosen as the ultimate purpose of a society, everything else not related to wealth in the society would become secondary. There would lead the society to become a harmful materialistic society.

The same logic could apply to other human society worthy goals: the survival of humanity, the protection of environment, the economic equality, communism, social welfare, various idealized utopia, or the glory of God. There could be chosen as one of goals of a society by elected leaders. None of them should be regarded as the ultimate purpose of the human society forever.

5.4.8.3 Principle of No Scientific Value System

With the same logic, the political equilibrium state has no scientific value system for the society. The importance of the value system in the decision making is well understood in economic and other social science.

Although the different value systems in the decision making have different scientifically forecastable consequences, science alone cannot determine the value systems. For example, science can tell you the different consequence of eating an apple or orange. But science cannot answer the question which one is more valuable. Again, there is a void created by the fundamental limitation of laws of physics. That void must be filled with personal religions/philosophies.

The personal choice of the ultimate purpose of life and the value system make the political equilibrium state very colorful and diverse.

Democracy, equality, freedom, and few other words are often called the universe values. In the framework of quantum politics, these are spontaneous orders rising from countless individual choices. They are not the scientific value system of the human society. However, individuals can choose them as parts of their personal value systems.

5.4.8.4 Principle of Separation Church and State

In quantum politics, personal religions and philosophies play fundamental roles cannot be replaced by science. Religious beliefs are very important for many citizens. While a free society respects the individual freedom to practice religion, the principle of separating church and state says that the government must not establish the official religion, and religious teachings must not be used to be the foundation of the political equilibrium state.

- (1) Religion teachings often define both the ultimate purpose of the humanity and the value systems for the public. As we discussed earlier, if the society is organized according to the ultimate purpose and official value system of a religion, the government would become theocracy not democracy.
- (2) Religious teachings can be contradictive to democratic principles of a free society. We cannot question why God likes or dislikes democratic principles.
- (3) Official religion violates the principle of voluntary contracts. Religious teachings are believed to be God's words. Even the collective will of all accountable citizens cannot modify God's words. If an official religion is imposed on all citizens, people are no longer truly free and became slaves to the ancient religion. Ordinary citizens are powerless to restrain the coercive power of a forced religion. The principle of voluntary contracts requires religion to be a strictly personal voluntary choice.

- (4) While religious teachings could be God's words, once they were written down in books, those books must obey laws of quantum mechanics. The Law of Information says that information in an ancient book will be out-dated because much of the world has changed since the book was written. The book cannot contain latest information. God has to give his latest words to keep the religion's teachings current. Only God can modify his own words. Therefore, these ancient teachings must not be used to establish a modern government.
- (5) Without the latest information, ancient religious teachings will have diminished predictive powers of future challenges. The law of prediction says that best prediction requires the latest information. Government constitutions and laws must have flexibilities to face unpredictable challenges. Ancient teachings would not offer flexibilities.
- (6) To put ancient religious teachings in the position of supreme laws of the land, it brings out a question of interpretation. Those people, who control the power of the interpretation of the meaning of God's words, will have effectively unlimited power.
- (7) Historically, mixing church and state had not worked neither for the state nor for the religion. Politicians loved to use the religion as a tool to attack and eliminate political enemies. Religious leaders, on the other hand, loved to use the power of government to attack and eliminate other imposing religions and differences of ideas such as the Darwin's evolution theory. Politics and religion became mutually corrupted each other.

In conclusion, there are many fundamental reasons to separate the church and state. Otherwise, both politics and religion became corrupted.

5.4.9 Principle of Fairness

The political equilibrium political state is a fundamentally free, fair, and just society. However, while the principle of political equality guarantees the equal political right for all accountable citizens, there are still many inequalities in a free society. For example, there will be only a handful of people who will win the lottery; there will be only a handful of people who will be elected as the president of the country; there will be only a handful of people to win the Olympic championship; and there will be only a handful of people to become rich in their lifetime.

The fairness principle says that in a free society, as long as the rules of a game and the process of the game are fair, the outcome of the game is fundamentally fair. The

game could be the lottery, the Olympic Games, financial markets, economy, legal proceedings, and political elections. In a free society, a critical function of the court system, Congress, and executive branch is to uphold the fairness of games for all accountable citizens.

The fairness principle can only guarantee the rules and the processes of games are fair but not the equality of the outcome for all accountable citizens. Thus, there will always be winners and losers in sports games, lottery games, financial markets, economy, and political elections in a free society.

When willing parties enter a game, the outcome of the game depends on many indeterministic quantum uncertainties in the future. The Law of Indeterminacy states that for a closed system, the outcome of the future event is indeterministic. The quantum uncertainty of the future is the fundamental property of nature and cannot be overcome by any means. Although the rules of the game are fundamentally fair to all parties at the starting point of the game, the outcome is usually not equally favorable to all parties. As long as the rules of the game are fundamentally fair, the inequality of the outcome is perfectly acceptable in a free society. The requirement of the absolute equality of the outcome is not only impractical in the real world, but also dangerous and harmful to sports games, financial markets, economy, education, and political systems.

Unfortunately, many people around the world are so obsessed with the dream of absolute equality of the outcome promised by socialism and communism that they are willing to violate the fairness principle, and even willing to risk democratic principles in politics and the voluntary exchange principle in economy.

Historically economic inequality is a favorite topic for many politicians and countless academics. Income inequality in the US has been often called an economic and social ill.

The first reason is that economic equality has always been a dream of humanity, and people have been complaining about the rich and poor disparity since the time of Jesus and Confucius. Many people mistakenly believe it is noble to promote economic equality. In fact, they should promote the fairness principle in a free society.

The second reason is that in free societies based on democratic principles are recent phenomena while authoritarian societies have been around since the dawn of written history. In authoritarian societies, unfair political and economic rules directly lead to economic inequality. Even today, many royal families around the world are still the richest people in the world. In free societies, unfair economic rules can be corrected through democratic political processes while in authoritarian societies, unfair economic rules are protected by unfair political rules. Therefore, many people mistakenly believe that inequality is the same as unfairness. In fact, in a free society, there is clear a difference between inequality and unfairness, while in an authoritarian society, inequality is often highly correlated with unfairness.

The third reason is lack of full understanding the role of quantum uncertainty in economy. Although the concept of luck is the same as the concept of quantum uncertainty, very few social scientists are willing to argue that luck is the fundamental cause of economic inequality, because nobody knows the true nature of luckiness. The physics laws of social science leaves no doubt that luck is directly from indeterministic behavior of elementary particles, and is the fundamental force shaping human society.

To summarize, economic inequality in a free society is not an economic and social ill. People should not confuse inequality with unfairness. The political equilibrium state is fundamentally fair to all parties involved.

5.4.10 Economic Equilibrium State

So far we have discussed the political structure of the equilibrium state. Now we turn our attentions to the economic equilibrium state.

Unlike the political equilibrium state, the economic equilibrium state depends on the advances of science and technology and the ultimate availability of the future energy sources. While physics laws of social science clearly state that there is clearly a limit of science and technology progress, we have few ideas where the science and technology progress would end.

Thermodynamically, our economic systems depend on the supply of the free energy. The ultimate equilibrium economic system depends on the sustainable level of the available free energy which includes the solar energy and the radioactive energy on the earth. As the free energy converts into the waste thermo energy, the environment would heat up. There is a hard thermodynamic limit about how much the waste thermo energy the surface of the Earth could tolerate. At the annual growth rate of 2.3% of the global free energy usage, the global economy would hit the hard thermodynamic limit of the waste heat in just about 400 years [59].

Therefore, there should be no doubt that we are going to reach the global economic equilibrium state. In next few sections, we will discuss the economic principles of the equilibrium political state.

5.4.10.1 Time and Political Equilibrium State

In physics, the equilibrium state is usually timeless. Except the fluctuations around the equilibrium states, the equilibrium state does not change.

In quantum politics, the political equilibrium state should also be timeless except the fluctuations around the equilibrium states. However, because we are very far from the economic equilibrium, the key economic principles of the equilibrium political state must be the maximization principles.

5.4.10.2 Relationship between Political and Economic System

Historically, there has been an uneasy relationship between the political and economic system as well as between political science and economics. In this section, we clarify the positions took by quantum politics.

In quantum politics, the economic system is a relatively independent part of the broader political system. In the equilibrium political state, the economic system functions under the democratic principles discussed earlier. For example, the maximum freedom includes the maximum degree of economic freedom; trades and voluntary exchanges can be viewed as one type of the voluntary buy and sell agreement; the rule of law provides a legal framework for economic activities; and principle of individual rights provides the private property ownership. Therefore, in the political equilibrium state, the economic

system must be a market-based economy. A centrally planned economy would violate many democratic principles we discussed earlier. On the other hand, the economic system is relatively independent of the political system. A centrally planned economy would work even in a democratic society at least in the short period. For example, the UK and US government imposed rationing during the World War II.

In the political equilibrium state, it is desirable to keep the political system and the economic system at some healthy distance. The economic system has its own set of democratic principles. The most important one is the principle of maximization wealth. The economic system has a universally-accepted ultimate purpose of maximizing the wealth of the society, while the political system must not have an ultimate purpose, as we discussed earlier. If the society would assume the maximizing wealth as the ultimate purpose, the society would take a dangerous road to serfdom of materialism with a corrupted political system.

In the framework of quantum social science, quantum politics and quantum economics share the same set of concepts, physics laws, tools, and methodologies. There are many important questions on the border line of politics and economics. For example, how to deal with the economic inequality? How to deal with the federal government fiscal deficits? What is the role of government in the economy? The general rule is to treat these questions as political questions rather purely economic questions because the economic system is an only part of the broader political system.

5.4.10.3 Principle of Maximum Wealth

The nature of the “invisible hand”, which efficiently organizes the worldwide economic system, has been in great interests to economists since Adam Smith. 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 the 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 maximization of wealth which is money or the socialized free energy.

In economics, at the consumer and corporate level, the primary responsibility of the person who is in charge of a balance sheet is to maximize the net worth of the balance sheet while keeping potential risks of bankruptcy in check. In the process of pursuing the maximization of wealth, the economy becomes for efficient because the people earning potential is maximized and the costs and wastes are minimized. If the net wealth is maximized for all individual balance sheets in an economy, then the net wealth of the aggregate balance sheet of entire economy is also maximized. Therefore, the aggregate net wealth of the aggregate balance sheet of an economy becomes a fundamental measure of the efficiency of the economy as whole.

As discussed earlier, the most important feature of the political equilibrium state is the maximum freedom. The individual economic freedom is always constrained by the economic scarcity. The maximization of wealth of individuals increases the individual economic freedom. Thus the principle of maximum freedom and the principle of maximization of wealth are closely related. Before the industrial revolution, most people

had to work very long hours just to provide enough food for the family. Today, most people in the wealthy countries rarely worry about enough food to eat. Thus people in the wealthy countries certainly are enjoying much more freedom of choices than farmers in the pre-industrial age.

5.4.10.4 Limits of Global Economic Development

The ongoing pursuing the maximization of the economic wealth has led to the global exponential economic growth since the industrial revolution. In physics including quantum economics, any exponential growth must stop eventually. In this section we will discuss some limits of the global economic developments.

In traditional economics, the factors of production include land, people, and capital. And some economists also include entrepreneurship. In quantum economics, the economic system is viewed through the thermodynamic lens just like analyzing any thermodynamic systems. In quantum economics, the factors of production include free energy, waste energy disposal, materials, waste material disposal, land and space, and people. Put it differently, a relatively independent economic unit located in certain spacetime is to take in free energy and raw material, provide products or services for the benefits of people, and produce the waste thermo energy and the waste material. That is the way our human body or any other thermodynamic systems work. We get free energy and material from foods and water, produce research papers or other things, and generate waste heat energy and other human wastes.

The limits of economic growth mean that one or more of these factors of production eventually hit the hard physical limits, and the global economy cannot grow any further and reaches the global economic equilibrium state.

(1) The free energy limit. The current working horse of the global economy is the fossil energy including coals, oils, and natural gases. However, the fossil energy is a finite resource and burning fossil energy produces carbon dioxide as wastes, which causes the global warming. Ultimately, the available solar energy is also limited. At the annual growth rate of 2.3%, the global free energy usage would surpass the available solar energy on the earth surface in just about 400 years [59]. The available nuclear energy could be potentially large.

(2) The waste heat energy limit. According to thermodynamics, most free energy will turn into the waste thermo energy. The waste thermo energy heats up the environment. The heat island effect is well known in major cities like Tokyo. Normally the Earth energy balance is managed very well to maintain the Earth surface temperature. However, when the waste thermo energy reaches the similar size of the total available solar energy on the Earth surface, the balance could tip off, and the Earth could not get rid of the waste heat into space without heating up the surface of the Earth into a boiling temperature. At the annual growth rate of 2.3% of the global free energy usage, the global economy would hit the hard thermodynamic limit of the waste heat in just about 400 years [59]. It should emphasize that the waste heat thermodynamic limit is very hard to overcome because it is independent of the free energy sources and technologies involved.

(3) The land and population limits. The human population is ultimately limited by the available foods. The land suitable for farming is a finite resource. While we don't know how much the genetic engineering can improve the global food production, we do know that food production will eventually have to compete with the solar energy industry for limited sun lights.

(4) Other limits. The industrial important materials are also finite resources if the recycle efforts are limited. The fossil energy is a finite resource. There is also the limit of the amount of waste carbon dioxide in the Atmosphere could be tolerated. The global economy has hit the soft limits such as the ecological limit is characterized by the massive extinction of animals, plants, and other living creatures.

(5) Some of the development limits could be regional. For example, the Chinese economy seems to have hit the air pollution limit. If Chinese continue to increase the amount coals being burned and the numbers of automobiles on the roads, they could choke themselves. China also has the water shortage problem. California and other western states in the US also have the acute water shortage problem.

Looking forward, while the world economy will continue to grow exponentially in the foreseeable future, the exponential grow will eventually end by hitting some of these hard physical limits.

5.4.10.5 Principle of Human Dignity

Economic inequality is an important feature of the political equilibrium state. In quantum politics, the fundamental causes of economic inequality are voluntary exchanges and the future uncertainty. For example, some people who buy stocks could get very rich like Warren Buffett while others might lose every penny invested. The stock trading is voluntary. While stock picking skills play an important role, the different results are also because of the future uncertainties.

Economic inequality is not a problem for a free society but could become problems only when economic rules or the economic processes are unfair. The key question becomes what is the role of government to help those unfortunate minorities who have performed poorly financially?

People certainly should not starve to death just because they lose jobs. Certain level of social welfare and social safety net are essential in the political equilibrium state. Social welfare assistance directly transfers money from some richer citizens to other citizens. The right amount of social welfare assistance should be decided by the balance of the principle of maintaining human dignity and the principle of maximization of wealth.

The government should mainly concern with the fairness of the economic rules, not economic inequality. The government does have responsibility to maintaining human dignity for those people who have performed poorly in the economic game.

5.4.10.6 Principle of Limitation of Science and Technology

In the framework of physics laws of social science, there are fundamental limitations of science and technology. There are important questions that cannot be answered by science and technology alone. For example, what is the ultimate purpose of life?

Science certainly has a well-defined boundary. There are only so many fundamental physics laws in nature. The string theory or quantum mechanics has been often called “the theory of everything”, which implies that there is one fundamental theory behind all causality relationships in the universe. If there is a limit of science, there will be a limit of technology as well, even though the nature of the limitation of technology is not very well understood right now.

The principle of limitation of science and technology plays a key role in defining the equilibrium political structure.

1. Limitation of science and technology implies there is no scientific ultimate purpose of the society and no scientific value system of the society. Personal religions and philosophies play critical roles in all decision making process.
2. Advances in the genetic engineering, information technology, and robotics provide an important challenge for the principle of political equality. If supermans, who have the superior intelligence than today’s human being, are created through the advanced technology, would supermans treat regular human equally?

Principle of limitation of science and technology implies the no superman theorem, which states that people with far superior intelligence do not have fundamental advantages over today’s human being and the principle of political equality still applies to supermans and average people. Although humans might be thousands of years away of completing “the theory of everything”, the fact that human intelligence is able to understand and figure out the theory for everything means that higher intelligence than human intelligence has no fundamental advantages over today’s human being.

3. The principle of limitation of science and technology implies the continuing progress of the world economy. The advances of science and technology are key drivers of the world economic progress, and will remain this way until reaching the fundamental limits of science and technology. Therefore, the maximization of wealth is an on-going process in the foreseeable future.

5.4.11 Principle of Globalization

Principle of globalization emphasizes the equilibrium political state is a worldwide political structure of the permanent peace integrating in the politics, economy, legal systems, military, police forces, health care, and all other areas with the global reaches.

One of the most noticeable trends after the cold war is the rapid progress of the globalization. The globalization process has uncanny similarities with the diffusion

process in physics. While the diffusion process in physics is governed by the second law of thermodynamics, it is questionable whether the second law of thermodynamics is applicable to the globalization process because the difficulty to define the key concept of entropy for the human society. The globalization process is an excellent example to highlight the needs to generalize the second law of thermodynamics to be applicable in the human society. The law of equilibrium is the generalized second law of thermodynamics for the human society. The fundamental driving force of the globalization is the choices made by human free wills.

The globalization process is led by the telecommunication revolution including the internet and international trades while the political and legal integrations are far behind. The internet has become the global market for ideas. With the diffusion of ideas and knowledge, the world has become an increasingly integrated village.

Applying the law of equilibrium on the global scale, it is no doubt that world economy will eventually reach the most efficient equilibrium state through international trades. The commodity markets, such as oil and copper, have already been globalized and tightly integrated. After China opened its door to the global trade in 1978, the global manufacturing sector has also been increasingly globalized. In the last few years, we have witnessed the rise of India in the computer software and service industry. With the integration of global economy and the flows of investment on the global scale, the world financial markets are also starting to integrate. For example, increasingly more stocks of foreign companies are listed in New York Stock Exchange and NASDAQ.

Even at this early stage of globalization, we start to witness winners and losers at the national-level in the globalization process. It is hard to believe that Ireland today enjoys the second highest income after Luxemburg largely because of forces of globalization. Ireland's pro-business policies, simple tax codes, and English-speaking population have attracted strong flows of oversea business and investments. In sharp contrasts, southern European countries like Greece, Italy, and Spain have been suffering high and increasing unemployment rates, unbearable social welfare burdens, and aging population. It appears that in a global economy, the competitions at the national-level are centered on economic policies, welfare systems, natural resources, educational-level of the labor force, work ethics, and political systems.

The continuing globalization has made many people angry and confused. Is there a way to stop or even reverse the globalization processes? No. According to the Law of Equilibrium, if people cannot prevent themselves from aging, people cannot stop or reverse the globalization processes. Quantum uncertainties, which cause people to age, are driving the global economics to integrate. However, the international politics could slow or fasten the globalization processes. People on this planet are brothers and sisters. What is wrong with trading with our own brothers and sisters? Ultimately, globalization of economy will be the economic foundation of permanent world peace. For the human race as a whole, the globalization of economy should use the global resources more efficiently, and should force different nations to adopt the best practices in terms of political governing, legal systems, and the welfare policies.

To summarize, the law of equilibrium is driving the global economy toward the most efficient global economic equilibrium state. The political and legal integration will follow. The war between nations will eventually stop and conflicts will be solved through voluntary contracts and legal processes. The globalization is the key to drive the world

towards the long-term global political equilibrium state of permanent world peace.

5.5 Summary of Democratic Principles

In previous section, we have presented the detail structure of the political equilibrium state. In this section, we will tie up a few loose ends, and summarize these 16 democratic principles.

5.5.1 Completeness of Democratic Principles

At this stage, we do not know whether these sixteen democratic principles are complete. What we do know is that these 16 principles are probably most important ones. Because many democratic principles are legal principles from long lasting voluntary contracts, one could add or delete this set of democratic principle when we have better understanding the global equilibrium political structure.

5.5.2 Logical Gap in Deriving Equilibrium Political Structure

This paper has applied physics laws of social science, the equivalent relationships with the hard rod system, the internal logics of quantum politics, and the empirical experience of the democratic experiments over last two hundreds of years to derivate the equilibrium political structure.

However, there is no doubt that there exists a logic gap. Basically, we have not derived the equilibrium structure rigorously from the first principles alone. The same problems exist in the condensed matter physics. Although in theory the most stable structures in the condensed matter physics could be derived from the first principles alone, in practice the calculations have been done rigorously only for a handful of very simple physical systems like the ideal gas and Ising models [53]. Multi-body problems are inherently hard in physics including quantum politics.

5.5.3 Governing Problem in Animal Kingdom

One obvious question regarding the most stable political structure is that why the nature evolution process over billions of years has not found the most stable political structure in the animal kingdom?

The short answer is that except the human beings, no animal spice could pass the accountable test. Animals cannot be held accountable for their behavior. However, many social animals do develop different sophisticated social structures. Empirically the methods of governing free wills in the animal kingdom have been perfected through billions of years of evolution.

Ants are social animals with fascinating political structures [60]. Army ants live in the deep woods of the Amazon jungle. Army ants are famous for their ability to kill and eat anything in their way, including insects, other ants, snakes, and even pigs. The awesome power of army ants is from their social organization. A colony consists of the queen, soldier ants, and worker ants. Soldier ants are responsible for defense of the colony and attacking enemies. Workers ants take care of the queen and search for food.

The queen ant is an extremely productive mother. She can produce 50,000 to 300,000 eggs in about one week.

In the world of army ants, queen, soldier ant, and worker ants are biologically very different. The principle of political equality does not apply to them. The queen is like a hard-working machine with super abilities rather than a lazy authoritarian ruler. Research has indicated that free wills of army ants are coordinated by chemical signals.

Scientists believe that chimpanzees are the closest living animal to humans in the evolution tree. Human ancestors branched away from chimpanzees as recently as six million years ago. In contrast to ants, there is no super chimpanzee with special ability in a group. Chimpanzees with the same sex and age are equal to each other biologically. There is generally a dominance hierarchy among males in a loose chimpanzee society. The dominant and subordinate relationship is established by the age, the physical force, political skills, and threats of violence. The highest-ranking status in a group is often gained through forming political coalitions with a brother or an older non-relative [61]. Very much like humans, chimpanzees need the group support to survive. Baby chimpanzees have to live with their mothers until about four years old. They hunt small animals collectively. On the peaceful side, chimpanzees touch and kiss to greet and groom each other's hair for comfort. On the violent side, because of the limited ability to communicate, chimpanzees often resort to bloody fights to settle conflicts. The ability of self-control of their free wills is essential for an individual to survive in a chimpanzee society.

Human have much in common with chimpanzees and ants. Scientists believe modern humanity started about 200,000 years ago. For much of human history, the common form of government was the tribe. The political structure of tribes resembles the group structure of chimpanzees in many aspects. Tribe leaders and elders have many privileges and responsibilities. Cities and nations were not invented until the agricultural revolution about 8,000 years ago. With a few exceptions of Greek democratic city-states, most cities and nations were ruled by monarchies. Thousands of years of history showed that monarchies were unstable political structures. Kings had so much power that the transition of power often invoked violence. New monarchies were often established as results of wars. Due to lack of special biological abilities, like queen ants, human kings and queens often used religion to claim the right to rule and backed it up with implied threats of violence against any rebellion. After the invention of mass media and the industrial revolution, people started to design alternative governments using democratic rules.

In conclusion, social animals like ants, chimpanzees, and humans have free wills. Freedom of individuals is balanced by needs of group supports, self-control, chemical signals, social hierarchy, threats of violence, and social rules. Insects, like ants, mainly use chemicals to influence and control each other. Chimpanzees have hierarchy group structures. Human have experienced tribes, monarchies, and democratic governments. The democratic government for a sizeable nation is possible only after the invention of the mass media.

5.5.4 Metastable Political Structures

Another obvious question regarding the most stable political structure is that why our ancestors have not found the most stable political structure over thousands of years?

The short answer is that our civilized history is too short. However, our ancestors did create many metastable political structures.

Studying these metastable political structures has many practical interests. One important application of the most stable political structure is to use the 16 democratic principles to examine these metastable structures because these metastable political structures can be viewed as variations of the most stable equilibrium political structure.

The metastable structures have different degrees of stability. The stability of a free and democratic society is achieved by the voluntary social contracts and governments rules through popular consents. The stability of undemocratic governments is achieved through implied violence and extracting popular consents through coercion.

If a society ignores the non-violence principle, the party with the greatest military power conquers the society and naturally becomes the political leaders. However, these forms of the governments are very unstable precisely because many democratic principles work against these governments. Citizens would demand freedom, equality, political rights, and accountability of government officials. Transferring the political leadership has always one of the biggest problems in these governments.

When a society assumes an ultimate purpose is a quick way that leads to serfdom. The totalitarian communist governments in Soviet Union, China, North Korea, Cambodia, and a few other countries had one ultimate purpose to create the communism utopia over the world with a moneyless, sharing products according to needs, and classless society. The fascist governments in German and Italy assumed the goal of proving the greatness of their nation and race at the cost of the individual freedom and interests of other countries. Combination of the religion and government leads to the theocracy governments.

The free and democratic governments come with many different variations because some of 16 democratic principles are violated. For example, constitutional monarch government of the United Kindom clearly violates the principle of political equality. The British people have preferred to preserve their historic tradition at the cost of equality. Even the constitution of United States violates many democratic principles. The violation of 16 democratic principles makes these governments less stable.

During the 20th century, the world has witnessed many interesting transitions of these metastable governments. During the period from 1901 to 2000, only a few countries including US, UK, Canada, Australian, Sweden, Switzerland enjoyed the unbroken chain of the stable governments, and all of these countries are sophisticated democratic governments with strong popular supports of many of 16 democratic principles. Many weak democratic governments collapsed because of the military coups. None of absolute monarchies of 1901 survived the 20th century. Many communist governments rose and collapsed.

Systematically studying these metastable governments is beyond the scope of this paper and will be published elsewhere.

5.5.5 Summary of Sixteen Democratic Principles

The following is a short summary by putting them together to show the common foundation of democratic principles.

The principle of maximum freedom says that a free society should give individuals the maximum freedom and liberty because people love freedom, and the maximum freedom will push the economy toward the most efficient state and bring out the maximum creativities in fields of science, technology, and arts according to the law of equilibrium.

The principle of nonviolence and voluntary contract is to resolve conflicts of free wills without violence and to restrain free wills without harming the individual's freedom by asking citizens to be held accountable for voluntary contracts agreed by themselves.

The accountable citizen test is designed to tell whether a citizen can be held fully accountable for his or her voluntary contracts. With the exception of underage children and people with mental disability, nearly all people in a society are accountable citizens.

The principle of political equality says that all accountable citizens must have equal political rights. The principle of political equality means that the equilibrium political state is a symmetric structure with the exchange symmetry.

The principle of the rule of law guarantees that voluntary contracts will be enforced.

The principle of separation of power rise naturally from voluntary contracts. If the power could only come from citizens' voluntary contracts, the political power will not be concentrated in just one or a few people acting as rulers.

The principle of check and balance is needed because we cannot predict precisely how elected officials will behave according to the law of prediction. Strong institutional checks and balances will minimize probabilities that elected officials would abuse their powers.

The principle of optimal decision making is to optimize the collective decision making processes through scientific forecasting, separation of power, balancing interests of all parties involved, carefully choosing the goals and value systems by balancing the science, religion, and political philosophies, and carefully choosing the decision making methods.

The principle of individual rights and fiduciary duty says that fundamental individual rights must be protected from the governments, and collective decision makers have the fiduciary duty to guard interests of other citizens including the minority, children, the unborn future generations, foreigners, animals, plants, other living creatures, and the environment in general. The chronic problems of budget deficits and environmental degradation are examples that political leaders have failed their fiduciary duty.

The principle of no scientific ultimate purpose comes from the fundamental limitation of science and technology. There are many important questions in social science that cannot be 100% answered by science. Science cannot answer what is the ultimate purpose for an individual or for a society. The human beings are fundamentally purposeful animals. While an individual can choose to have an ultimate purpose according to his free wills, a society must not have an ultimate purpose. To establish an ultimate purpose for the society would lead the society on the road to serfdom.

The principle of no scientific value system follows the similar logics. Because the value system is essential for virtually all decision making, quantum politics emphasizes

the importance of personal religions and philosophies. The political equilibrium structure emphasizes the diversity of human behavior and the culture pluralism.

The principle of separation of church and state says that the government must not establish the official religion, and no ancient religious teachings should be used as the foundation of the constitutions. The law of information says ancient religious teachings are out dated. The law of prediction says ancient religious teachings have diminished powers to predict future challenges.

The principle of fairness says that in as long as the rules and the process of running a game are fair, the outcome of the game is fundamentally fair. The government should mainly concern the fairness of competition rules not outcome inequality such as the rich and poor gap.

The principle of maximizing wealth says that a human society will always try to maximize the wealth. The increasing wealth is a way to maximize the individual freedom.

The principle of human dignity says that a free society and the government have obligations to help its less fortunate citizens maintain human dignity through the social welfare system.

The principle of limitation of science and technology sets the boundary of science and technology. The decision making processes must go outside the boundary to use personal religions and philosophies. On the other hand, the individual freedom, economic development, and science and technology progresses would push the human knowledge to the limits of science of technology.

The principle of globalization says that the law of equilibrium will push the globalization of the political, economic, and legal systems toward the world permanent peace.

These 16 democratic principles are also summarized in a figure in the next page for the easy reference.

All these 16 principles are based the concept of free will and physics laws of social science. Because people's free wills are quantum uncertainties and the behavior of free will can be only described by quantum mechanics, these sixteen democratic principles are rooted in quantum mechanics, and they are universally applicable to all nations and the world.

These 16 democratic principles can be grouped into three categories:

- (1) Interpersonal relationships. These 9 principles reflect the interpersonal relationships in the equilibrium state include principle of nonviolence and voluntary contract, principle of political equality, principle of the rule of law, principle of separation of power, principle of check and balance, principle of optimal decision making, principle of individual rights and fiduciary duty, principle of fairness, principle of human dignity, and principle of globalization.
- (2) People and environment relationship. These 3 principles reflect the principle of maximizing wealth, principle of limitation of science and technology, and principle of individual rights and fiduciary duty.

(3) People's personal freedom, philosophy, and spirituality. These 4 principles are the principle of maximum freedom, principle of no scientific ultimate purpose, principle of no scientific value system, principle of separation of church and state.

It is easy to see that the political equilibrium state has very refined interpersonal relationships. That is not surprising because the politics is about resolving conflicts among free wills.

Principle of Maximum Freedom



Principle of Nonviolence and Voluntary Contract



Principle of Political Equality

Principle of Rule of Law

Principle of Separation of Power

Principle of Check and Balance

Principle of Optimal Decision Making

Principle of Maximizing Wealth

Principle of Human Dignity

Principle of Limitation of Science and Technology

Principle of Globalization

Principle of Individual Rights and Fiduciary Duty

Principle of No Scientific Ultimate Purpose

Principle of No Scientific Social Values

Principle of Separation of Church and State

Principle of Fairness

5.5.6 Summary of Political Equilibrium State

In this section, we will prove that a democratic government based these sixteen democratic principles must be the political equilibrium state.

The law of equilibrium says that in the long term, free wills in a nation will explore all possibilities to find the best way of governing free wills. A government based on these democratic principles must be the political equilibrium state of a nation for the following reasons:

First, a government allows the maximum freedom for its individual citizens. From physics, we know that the maximum freedom is equivalent to the maximum entropy of a physical system. The Second Law of Thermodynamics guarantees that a closed system with the maximum entropy must be the equilibrium state. Therefore, a government allows the maximum freedom for its individual citizens is probably the political equilibrium state.

Second, a society, which obeys the principle of political equality, has the exchange symmetry. The symmetric structure is a common feature shared by many equilibrium states in physics, chemistry, and biology. For example, many snow flakes have beautiful symmetries.

Third, a government based on these democratic principles systematically encourages its citizens to pursue excellence in economy, finance, science, technology, arts, sports, and many other human activities. Excellence in economy, finance, science, and technology implies that the society will be productive, prosperous, and competitive.

Fourth, a government based on these democratic principles is fundamentally fair and just to all accountable citizens, children, unborn future generations, foreigners, animals, and other living creatures. A fair government should have minimum violence, and should be the most stable form of all possible governments.

To summarize, a society, which is based on these sixteen democratic principles, will be a free, fair, just, productive, prosperous, peaceful, and competitive. We reach another important conclusion of this paper, that a government based these democratic principles must be the most stable political equilibrium state of any nation and the world.

6 Some Implications of the Equilibrium Political Structure

The humanity governing problem has been around for thousands of years, and certainly is one of the most important unsolved problems in all fields of science. This paper has presented a scientific solution applying physics laws of social science. Solving this problem scientifically will certainly have profound impacts on many aspects of the human society. In this section, we will discuss some of these impacts.

6.1 Quantum Politics Works

The humanity governing problem is one of most difficult problems in all fields of social science. The fact that such a difficult problem can be reduced to a many-body problem and solved using the framework of quantum politics outlined earlier, means that the quantum politics works. Now many concepts in politics become precisely defined

physics concepts. For example, in quantum politics, the freedom means the freedom to make choices. It can be quantified just like any physics concept like masses and momentum. The principle of political equality means equality of political rights. The economic inequality is fundamentally caused by the voluntary exchanges and future uncertainties. Physics is value-neutral, precise, dry, and cold.

If politics becomes a branch of quantum physics, all political problems becomes physics problems. The politicians become political engineers. In order to solve any political problem, the first thing to ask should always be what quantum politics says about this problem. When a good automobile mechanic fixes a problem in a car, the good place to start is always trying to understand what kind of physics is involved.

Political decisions often impact lives of millions of people. The world would certainly benefit when politicians think rationally and systematically like good engineers.

6.2 Fundamental Design Flaws of United States Constitution

Comparing the equilibrium political structure and the United States constitution, it becomes apparent that the US constitution has many fundamental design flaws.

The constitution is certainly one of the most important documents in the world history. It was designed wisely and beautifully by the US constitution framers. 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. In this paper, we 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 during the great compromise.

Today many social and economic problems in US can be traced to the fundamental design flaws of the constitution.

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 constitution. The principle of nonviolence says that conflicts should be resolved peacefully with compromises.

Historically, American Civil War and slavery are some other examples of the design flaws of the US constitution.

Because the topic of design flaws of the US constitution is so important and interesting, details will be published elsewhere in a standalone article.

Because the sixteen 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. Details will be published elsewhere.

6.3 Permanent World Peace

In this section, we will apply democratic principles to the world. The law of equilibrium clearly says that there is a global political equilibrium state, which corresponds to the permanent world peace.

The idea of a world government is as old as politics [62-69]. Confucius proposed a peaceful ideal world “DaTong”, which is an ideal that has inspired Chinese for thousands of years. The ancient Greek thinker Isocrates [19] argued that a unified government for the warring Greek city-states would keep them from fighting with each. Immanuel Kant proposed [62] in his Perpetual Peace a league of nations for the world peacekeeping. With the invention of nuclear weapons, the idea that humanity could destroy itself with a turn of a switch became a very real threat, Albert Einstein wrote in 1946 that “A world government must be created which is able to solve conflicts between nations by judicial decision. This government must be based on a clear-cut constitution which is approved by the governments and nations and which gives it the sole disposition of offensive weapons.” In the 20th century, the Leagues of Nations and the United Nations were created to address the international securities and other issues. While the ideal of a world government has been always alive in people’s mind, the poor understanding of political theories, the mistrust of different nations, the fear of forcing to adapt new ways of life, and the worry about the potential abusive global despotism have kept a centralized world government as a remote dream.

It is very interesting to see that many democratic principles are actually rooted in quantum mechanics. Violation of these principles will end up with less perfect societies. In the long run, those less perfect societies are unstable and most likely to be replaced by more perfect societies. Because these democratic principles are rooted in quantum mechanics and quantum mechanics is universal laws of physics, the Law of Equilibrium clearly says that these democratic principles actually defined a global equilibrium state of politics.

The accountable citizen test does not discriminate on nationality. The principle of political equality leaves us no choice but to recognize that nationality is a temporary concept. Archaeology and human genomics research support the ideas that we are all truly brothers and sisters. The concept of nation is probably a few thousand years old while humanity is about 200,000 years old.

The nationality is actually preserved in the world permanent peace political structure. The difference is that now national governments become the local governments while the world government becomes the top federal government. The world government will be a simple and weak government only handles the global governing issues. Since there is no external threat to the world, there is no need to have a strongly centralized world government with a powerful standing army. The political power will be divided properly between the world federal government and national governments.

Since the democratic principles must be applicable on the global scale, by applying the democratic principle on the global scale, the law of equilibrium guarantees that there will be a global equilibrium state of politics. The global equilibrium state has the following features:

- People have maximum freedom.

- People's free wills are only restrained by voluntary contracts.
- People have fundamental individual rights.
- There will be the rule of law.
- All accountable citizens in the world have equal political rights.
- There will be a top world government and many local national governments to carry out the enforcement of the rule of law.
- The power of the world government will be limited to give the maximum freedom to all citizens.
- There will be different nations, states, cities, and counties for the administration purpose.
- The world government will be a democratic government with the checks and balances of power.
- All collective decision making process will be optimized.
- Future generations, animals, all other living creatures, and the environment will be treated fairly according to the principle of fiduciary duty.
- People will have the freedom of personal religion. There will be separation of church and state.
- There will be a global economy based on voluntary exchanges and free trades.
- The world government will encourage its citizens to pursue excellence in science, technology, arts, sports, and many other human activities.
- Culture diversity and pluralism will be encouraged.
- There will be polices to enforce the rule of law.
- There will be no army, and no nuclear weapons or other weapons of mass destruction.
- People have to rights to travel all over the world without ever worrying visa.
- People are guaranteed to have their basic needs for foods and other essentials to maintain their human dignity.
- There will be permanent world peace.

Once we understand the nature of free will, we realize that humans are simply giant molecules with free wills. Over a long time, the Law of Equilibrium will drive the human society to the global equilibrium state. Because of the universality of the Law of Equilibrium, the ultimate equilibrium state is inevitable. Human free will can accelerate or delay the process. However, any human individual will not be able to change the direction of time.

In summary, this paper proves that quantum physics says that we can create a free, fair, just, peaceful, and prosperous world for ourselves and all future generation. There are many advantages of having a worldwide democratic government. All other alternatives are ultimately unstable. It solves the world peace and nuclear weapon problem. The globalized world economy will be the most efficient in allocating the scarce global resources. Most importantly, it is mathematically fair and just to treat everyone with respect and dignity.

6.4 Permanent World Peace is Not Utopia

While the equilibrium political structure is significantly improvement over the legal principles in the US constitution, the basic structure is virtually the same. In other

words, the success of the US constitution proves that the permanent world peace is not a utopia. In essence, if the United States constitution is applied to the world today, we will have a permanent world peace immediately. People in US originally came from every corner on the earth. If the improved version of the US constitution is applied to the world, the result should be even better.

Theoretically, the equilibrium state is rooted in quantum mechanics. It is a scientific concept. As long as you follow the quantum mechanics logics, everyone will reach the same identical conclusion that there will be a global equilibrium state. Other utopias like communism are not very different from wild dreams without a scientific base.

6.5 Democratic principles and Social Changes

In the condensed matter physics, the system changes and fluctuations around the equilibrium states can be quantified with the hydrodynamic modes characterized the system. For example, the changes of a cup of water is described by a set of hydrodynamic modes [53] include the heat diffusion equation, the sound wave equation, and Navier-Stokes equation.

The same idea is applicable to the human society. The long term changes of the human society are governed by the same sixteen democratic principles. The sixteen democratic principles are also hydrodynamic modes of the equilibrium political structure.

For example, according to the principle of maximum freedom, the world has been becoming more freedom for individuals in general. If the freedom of choices is quantified worldwide, there is a trend towards individual freedom. However, the process is indeterministic. In other words, there will be less freedom sometimes.

Carl Marx famously said that the history of all hitherto existing society is the history of class struggle. While the class struggle is not a hydrodynamic mode, strictly speaking Marx is wrong. However, there are several hydrodynamic modes related to the class struggle. For example, the principle of political equality and principle of freedom implies that ordinary people would fight with authoritarian rulers for their equality and freedom. In some sense, Carl Marx is right that there are universal underlying dynamics for social changes.

The discovery of the hydrodynamic modes of the human society essentially opens a brand new way to study world political, economic and social dynamics, and study the world history and predict the future. Because this topic is very important and interesting, the details will be published in a standalone article elsewhere.

6.6 Falsify Solution to Humanity Governing problem

The solution to the humanity governing problem presented in this paper is a physics theory. Therefore, it should be able to falsify the theory with the logical reasoning or empirical observations.

First, the simplest way to falsify the theory in this paper is to find logic flaws over the framework of quantum social science. Because everything in quantum social science is physics, everyone else should be able to reproduce the same conclusions, just like the string theory in quantum physics.

Second, there are many logical consequences following the solution to the humanity governing problem. For example, there are fundamental design flaws of the US constitution. There is an equilibrium solution to the government budget deficits. If these logical consequences do not make any sense in reality, it could mean there are serious problems in the solution to the humanity governing problem.

Third, the solution to the humanity governing problem is a value-free long term forecast of the human society using the law of equilibrium. Here the long term could mean hundreds or even thousands of years due to the slow dynamics of the human society. It is not practical to wait that long to find out whether the solution is valid or not. However, the short-term social changes could be analyzed with the 16 hydrodynamic modes of the equilibrium political structure. These short-term forecasts can be falsified against the empirical observations.

Therefore, as a scientific theory, the solution to the humanity governing problem can be falsified.

7 Concluding Remarks

Since Issac Newton discovered the laws of motion in 1687, for the next 300 plus years, social scientists are looking for the physics laws governing human society. This paper has described the framework of the quantum politics using physics laws of social science, and have successfully applied the framework to solve the humanity governing problem, which certainly is one of the most difficult problems in social science.

In several other papers [13, 70], the same physics laws of social science have been successfully applied to economics to establish a fundamental equation of economics [13] and a scientific macroeconomic model [70]. Thus, there are good reasons to believe that physics laws of social science are indeed the physics laws governing human society.

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