Preface

A few years away from the centennial celebration of general relativity, the author of this monograph feels blessed for having the opportunity to present *YinYang Bipolar Relativity* to readers of the world. It seems surreal but, hopefully, the book can serve three purposes: (1) to add a piece of firework to the centennial celebration; (2) to introduce a deeper theory that transcends spacetime; (3) to reveal the ubiquitous effects of quantum entanglement in simple, logically comprehendible terms. Certainly, whether it is indeed an applicable deeper theory or just a piece of firework is ultimately up to the readers to make a judgment. As pointed out by Einstein: *"Experience remains, of course, the sole criterion of the physical utility of a mathematical construction. But the creative principle resides in mathematics."* (Einstein, 1934)

In this book we refer to relativity theories defined in spacetime as *spacetime relativity*. Thus, all previous relativity theories by Galileo, Newton, Lorenz, and Einstein are classified as spacetime relativity. This terminological treatment is for distinguishing *YinYang bipolar geometry* from *spacetime geometry*.

Regarding judgment, believe it or not, in the world-wide scientific community there may be more Chinese who emotionally resent the word "YinYang" due to misinformation or misunderstanding than Westerners who scientifically oppose the YinYang cosmology. This may sound ironic but is actually a historical phenomenon with socioeconomic reasons. First, most modern day Chinese want China to be integrated into the modern world and don't care much about YinYang, deemed an unscientific concept of the old school. Secondly, some overseas Chinese are concerned that the word "YinYang" might offend Western colleagues.

Subsequently, while the word "YinYang" has appeared in numerous Western publications spanning almost the whole spectrum of arts and sciences including but not limited to the prestigious journals *Science, Nature,* and *Cell*, some Chinese scholars including some researchers in traditional Chinese medicine (TCM) tend to shun YinYang. For instance, a few years ago a well-established Chinese American friend strongly advised (or demanded) the author to drop the word "YinYang" from titles of future submissions to avoid *"hurting the others' feelings."*

Western scholars, on the other hand, are free from carrying the above historical or socioeconomical baggage and are curious about YinYang. While many Westerners regard "YinYang" objectively as a philosophical word related to nature, society, and TCM, some Western scientists expect YinYang to play a critical or even unifying role in modern science. Here are a few examples:

1. Regarding the *"hurting the others' feelings"* matter, the author consulted a few "Westerner" colleagues and was given exactly the opposite advice: YinYang symbolizes the two energies of dynamic equilibrium, harmony, and complementarity; bipolarity without YinYang is often used in the West to indicate disorder, chaos, and dichotomy. (Note: Bipolarity is used in this book as YinYang bipolarity.)

2. Legendary German mathematician Leibniz – co-founder of calculus – invented the modern binary numeral system in the 17th century and attributed his invention to YinYang hexagrams recorded in the oldest *Chinese Book of Change – I Ching* (Leibniz 1703) (Karcher 2002).
3. Legendary Danish physicist Niels Bohr, father figure of quantum mechanics, brought YinYang into quantum theory for his particle-wave complementarity principle. When he was awarded the Order of the Elephant by the Danish government in 1947, he designed his own coat of arms which featured in the center a YinYang logo (or Taiji symbol) with the Latin motto *"contraria sunt complementa"* or *"opposites are complementary."*
4. Following Einstein's lead that history and philosophy provide the context for science and should be a significant part of physics education (Smolin 2006 p310-311), a group of renowned scientists and linguists noticed that different philosophies and cosmologies could result in different cultures and linguistic terms which in turn could make a major difference in the interpretation and understanding of space, time, and the quantum world (Alford 1993). Specifically, the word *"YinYang"* is deemed a most suitable noun for characterizing quantum interaction. As stated by linguist Alford (Alford 1993), YinYang *"represents a higher level of formal operations" "which lies beyond normal Western Indo-European development."*
5. A widely referenced genetic agent (protein) discovered at Harvard Medical School is named Yin-Yang 1 (YY1) (Shi *et al.* 1991) due to its ubiquitous repressor-activator (YinYang) functionalities in gene expression regulation in all cell types of living species (Jacobsen & Skalnik 1999).
6. A YinYang Pavilion created by American artist Dan Graham is dedicated to MIT and housed in Simmons Hall on the MIT campus (MIT News 2004).
7. A New York Times science report (Overbye 2006) described a subatomic particle discovered at the Fermi National Accelerator Laboratory as a *"YinYang dance"* that can change polarity three trillion times per second (Fermilab 2006).

While Western science and media don't seem to have problem with the word "YinYang", the word is, nevertheless, largely mysterious, albeit extremely pervasive. Its pervasive and mysterious nature can be characterized with a famous quote from Einstein: *"After a certain high level of technical skill is achieved, science and art tend to coalesce in esthetics, plasticity, and form. The greatest scientists are always artists as well."*

Evidently, a resolution to the *"science and art"* YinYang mystery bears great significance and has become imperative for the advancement of science and humanity. Unfortunately, such a resolution has been deemed scientifically impossible by many. This monograph is intended to accomplish the mission impossible based on the following observations and assertions:

1. The *"science and art"* YinYang paradox is similar to particle-wave quantum duality in Niels Bohr's complementarity principle. However, quantum mechanics has so far only recognized YinYang complementarity but failed to identify the essence of YinYang bipolarity. Without bipolarity, any complementarity is less fundamental due to the missing "opposites." In one word, the negative and positive poles such as action-reaction forces and particle-antiparticle pairs are the most fundamental opposites of Mother Nature but science-art, particle-wave, and truth-falsity are not exactly YinYang bipolar opposites.
2. Resolving the YinYang mystery is essentially the same as logically defining Aristotle's causality principle, axiomatizing all of physics (Hilbert 1901), resolving the EPR paradox (Einstein, Podolsky

& Rosen 1935), or providing a logical foundation for the grand unification of general relativity and quantum mechanics.

3. The *"higher level" "post-formal"* YinYang operation entails a philosophically different logical foundation that does indeed lie *"beyond normal Western Indo-European development"* and such a logical foundation is attainable in formal mathematical terms.

OBJECTIVE

The objective of this monograph is to present YinYang bipolar relativity as an equilibrium-based unifying computing paradigm with a minimal but most general axiomatization of physics that (1) logically defines bipolar quantum causality; (2) logically unifies gravity with quantum theory; (3) brings relativity and quantum entanglement to the real-world of microscopic and macroscopic agent interaction, coordination, decision, and global regulation in physical, social, and life sciences especially in quantum computing and exploratory knowledge discovery.

INTENDED AUDIENCE

The intended audience of the book includes, but is not limited to,

1. Students, professors, and researchers in mathematics, computer science, artificial intelligence, information science, information technology, data mining and knowledge discovery. These readers may find bipolar mathematical abstraction, bipolar sets, bipolar dynamic logic, bipolar quantum linear algebra, bipolar quantum cellular automata and their applications useful in their fields of teaching, learning, and research.
2. Students, professors, and researchers in quantum computing, physical sciences, nanotechnology, and engineering. These readers may find both of the theoretical and application aspects useful in their field of teaching, learning, and research. It is expected that quantum computing will be a major interest to these readers.
3. Students, professors, and researchers in bioinformatics, computational biology, genomics, bioeconomics, psychiatry, neuroscience, traditional Chinese medicine, and biomedical engineering. These readers may use the book material as an alternative holistic approach to problem solving in their fields of teaching, learning, research, and development.
4. Students, professors, and researchers in socioeconomics, bioeconomics, cognitive science, and decision science. These readers may find the mathematical tools and the quantum computing view useful in their fields of teaching, learning, research, and development.
5. Industrial researcher/developers in all fields who are interested in equilibrium-based modeling, analysis, and exploratory knowledge discovery in quantum computing, cognitive informatics, and life sciences. These readers may actually apply the theory of bipolar relativity for dealing with uncertainties and resolving unsolved problems in uncharted territories.

Limited logical and mathematical proofs of related theorems are included in Chapters 3-8. The proofs are for the convenience of logicians and mathematicians. They can be skipped by non-mathematical readers who are only interested in using the mathematical results for practical applications.

ORIGIN

While YinYang bipolar relativity can trace its philosophical origin back to ancient Chinese YinYang cosmology which claimed that everything has two sides or two opposite but reciprocal poles or energies, the formal theory presented in this monograph, however, is not the result of experimentation or elaboration of ancient Chinese YinYang but the result of free invention in the following spirit:

1. According to Einstein logical axiomatization of physics is possible: *"Physics constitutes a logical system of thought which is in a state of evolution, whose basis (principles) cannot be distilled, as it were, from experience by an inductive method, but can only be arrived at by free invention."* (Einstein 1916).
2. According to Einstein: *"Evolution is proceeding in the direction of increasing simplicity of the logical basis (principles)." "We must always be ready to change these notions – that is to say, the axiomatic basis of physics – in order to do justice to perceived facts in the most perfect way logically."* (Einstein 1916)
3. According to Einstein: *"... pure thought can grasp reality, as the ancients dreamed"* and *"nature is the realization of the simplest conceivable mathematical ideas."* (Einstein 1934)
4. According to Einstein the grand unification of general relativity and quantum mechanics needs a new logical foundation: *"For the time being we have to admit that we do not possess any general theoretical basis for physics which can be regarded as its logical foundation."* (Einstein 1940)
5. According to Einstein: *"Put your hand on a hot stove for a minute, and it seems like an hour. Sit with a pretty girl for an hour, and it seems like a minute. That's relativity."*

In the last quote, Einstein used sorrow and joy to hint the two sides of YinYang in general. Symbolically, the two sides can be paired up as a bipolar variable and generalized to action-reaction forces denoted *(-f, +f)*, negative-positive electromagnetic charges denoted *(-q, +q)*, matter-antimatter particles *(-p, +p)* or the equilibrium-based bipolar variable (e^-, e^+) in a YinYang bipolar dynamic logic (BDL) for the theory of YinYang bipolar relativity (Zhang 2009a,b,c,d).

While space and time are not symmetrical to each other, not quantum entangled with each other, and not bipolar interactive, the concept of YinYang bipolarity is symmetrical and applicable in both microscopic and macroscopic worlds of physical and social sciences for characterizing agent interaction and bipolar quantum entanglement. Arguably, if space is expanding, spacetime has to be caused by something more fundamental; if YinYang bipolarity can survive a black hole due to particle-antiparticle emission or Hawking radiation, the logical foundation of physics has to be bipolar in nature; if particle-antiparticle pairs and nature's basic action-reaction forces are the most fundamental components of our universe, YinYang bipolar relativity has to be more fundamental than spacetime relativity. These arguments provide a basis for the transcending and unifying property of YinYang bipolar relativity beyond spacetime geometry.

Historically, even though YinYang has been the philosophical basis in the actual practice of TCM for thousands of years in China, it has failed to enter the arena of modern science until recent decades. It is a living proof to Einstein's assertion that *"Physics constitutes a logical system of thought which is in a state of evolution, whose basis (principles) cannot be distilled, as it were, from experience by an inductive method, but can only be arrived at by free invention."* (Einstein 1916).

Here are a few major modern developments in YinYang research:

1. **Biological YinYang.** The most noticeable result in this category is the discovery of the genetic regulator protein Yin Yang 1 (YY1) in 1991 at Harvard Medical School (Shi *et al.* 1991). YY1 exhibits ubiquitous repressor-activator functionalities in gene expression regulation in all types of cells of living species. The discovery of YY1 marks the formal entry of the ancient YinYang into genomics – a core area of bioinformatics. Since then, YY1 has been widely referenced by the top research institutions in the US and the world.
2. **Bayesian YinYang (BYY)**. BYY harmony learning **(**Xu 2007) has been widely cited and has become a well-established area in neural networks.
3. **Binary or Boolean YinYang**. Boolean YinYang (Zhang 1992; Kandel & Zhang 1998) follows Leibniz binary interpretation of YinYang. The binary interpretation provides a basis for all digital technologies.
4. **Bipolar YinYang.** Bipolar YinYang consists of YinYang bipolar sets, bipolar dynamic logic, bipolar quantum linear algebra, YinYang-N-Element quantum cellular automata, bipolar quantum entanglement, and the theory of YinYang bipolar relativity for applications in quantum computing, socioeconomics, and brain and life sciences (Zhang and coauthors, 1989-2009) (Zhang 1996-2010). Bipolar YinYang follows the YinYang cosmology that claims everything in the universe including the universe itself has two opposite reciprocal poles or energies.

This book follows the direction of bipolar YinYang. However, it should be remarked that the above different approaches to YinYang are interrelated or overlapped with each other. The repression and activation regulatory properties of Yin Yang 1 are bipolar in nature; YinYang equilibrium is essential in YinYang harmony; the two poles of YinYang are truth objects plus reciprocal bipolarity. From a physical science perspective, (-,+) bipolarity and symmetry in particle physics can also be considered evidence that supports the YinYang bipolar cosmology. From a decision science perspective, YinYang has been an influential philosophy in business management, socioeconomics, and international relations especially in Eastern countries. Noticeably, the national flag of South Korea is featured with a YinYang logo.

Indeed, YinYang has entered every aspect of the Western as well as the Eastern societies. Due to its lack of a unique formal logical basis, however, YinYang theory has remained largely mysterious. This book is to fill this gap. Although the technical ideas have been partially reported in refereed journal and conference articles, they have never been systematically presented as a coherent relativity theory in a monograph.

CENTRAL THEME

It is well-known that microscopic and macroscopic agents and agent interactions are essential in physics, socioeconomics, and life sciences. Unifying logical and mathematical axiomatization of agent interaction in microscopic and macroscopic worlds including but not limited to quantum, molecular, genetic, and neurobiological worlds is needed for scientific discoveries and for the coordination and global regulation of both non-autonomous and autonomous agents. Since agent interactions are governed by physical and social dynamics, the difficulty of axiomatizing agent interactions can be traced back to Hilbert's effort in axiomatizing physics, Aristotle's causality principle, the concept of singularity, and bipolar equilibrium.

English mathematical physicist Roger Penrose described two mysteries of quantum entanglement (Penrose 2005, p591). The first mystery is identified as the phenomenon itself. The second one, accord-

ing to Penrose, is *"How are we to come to terms with quantum entanglement and to make sense of it in terms of ideas that we can comprehend, so that we can manage to accept it as something that forms an important part of the workings of our actual universe? .. The second mystery is somewhat complementary to the first. Since according to quantum mechanics, entanglement is such a ubiquitous phenomenon – and we recall that the stupendous majority of quantum states are actually entangled ones – why is it something that we barely notice in our direct experience of the world? Why do these ubiquitous effects of entanglement not confront us at every turn? I do not believe that this second mystery has received nearly the attention that it deserves, people's puzzlement having been almost entirely concentrated on the first."*

A major argument of this monograph is that equilibrium or non-equilibrium, as a physical state of any dynamic agent or universe at the system, molecular, genomic, particle, or subatomic level, forms a philosophical chicken and egg paradox with the universe because no one knows exactly which one created the other in the very beginning. Since bipolar equilibrium (or non-equilibrium) is a generic form of equilibrium (or non-equilibrium), any multidimensional model in spacetime geometry is not fundamental. *It is postulated that the most fundamental property of the universe is YinYang bipolarity.* Based on this postulate, bipolar relativity is presented that extends YinYang cosmology from *"Everything has two reciprocal poles"* to a formal logical foundation for physical and social sciences which claims that *"Everything has two reciprocal poles and nature is the realization of YinYang bipolar relativity or bipolar quantum entanglement."*

The main idea of the book starts with the paradox *"logical axiomatization for illogical physics" (LAFIP)* (Zhang 2009a) on Hilbert's Problem 6. It is observed that without bipolarity the bivalent truth values 0 for false and 1 for true are incapable of carrying any shred of direct physical syntax and semantics, let alone illogical physical phenomena such as chaos, particle-wave duality, bipolar disorder, equilibrium, non-equilibrium, and quantum entanglement. Therefore, truth-based (unipolar) mathematical abstraction as a basis for positivist thinking cannot avoid the LAFIP paradox. It is suggested that this is the fundamental reason why there is so far no truth-based logically definable causality, no truth-based axiomatization of all physics, no decisive battleground in the quest for quantum gravity, and no logic for particle-wave duality, bipolar disorder, economic depression, big bang, black hole, and quantum entanglement.

Furthermore, it is pointed out that, while no physicist would say *"electron is isomorphic to positron"*, it is widely considered in logic and mathematics that "-1 is isomorphic to +1" and (-,+) bipolar symmetry, equilibrium, or non-equilibrium is not observable. If we check the history of *negative numbers*, we would find that the ancient Chinese and Indians started to use negative numbers thousands of years ago but European mathematicians resisted the concept of negative numbers until the 18th centuries (Temple 1986, pp.141) (Bourbaki 1998) (Martinez 2006).

Regardless of the great achievement of Western science and technology, it is undoubtedly necessary to bridge the gap between the Western positivist thinking and the Eastern balanced thinking for solving unsolved scientific problems. As *"passion for symmetry"* can *"permeate the Standard Model of elementary particle physics"* and can unify *"the smallest building blocks of all matter and three of nature's four forces in one single theory"* (The Royal Swedish Academy of Sciences 2008), it is not only reasonable but also inevitable to explore the bipolar equilibrium-based computing paradigm (Note: Equilibrium-based is to equilibrium and non-equilibrium as truth-based is to truth and falsity with fundamentally different syntax and semantics).

SYNOPSIS

YinYang bipolar relativity is intended to be a logical unification of general relativity and quantum mechanics. The monograph can be considered the first step to address the gigantic topic with real-world applications in both natural and social sciences focused on quantum computing and agent interaction in socioeconomics, cognitive informatics and life sciences. Subjects opened in the book can be further addressed in succeeding volumes in depth.

The main body of the book starts with a new set-theoretic logical foundation. To avoid LAFIP, bipolar set theory is introduced with a holistic equilibrium-based approach to mathematical abstraction. Bipolar sets lead to YinYang bipolar dynamic logic (BDL). A key element of BDL is bipolar universal modus ponens (BUMP) that provides, for the first time, logically definable causality. It is shown that BDL is a non-linear bipolar dynamic fusion of Boolean logic and quantum entanglement. The non-linearity, however, does not compromise the basic law of excluded middle (LEM) and bipolar computability. Soundness and completeness of a bipolar axiomatization are asserted. Bipolar sets and BDL are extended to bipolar fuzzy sets, bipolar dynamic fuzzy logic (BDFL) and equilibrium relations.

With the emergence of space, time, and bipolar agents, a completely background independent theory of bipolar relativity, the central theme of the book, is formally introduced based on bipolar sets and BDL. It is shown that, with bipolar agents and bipolar relativity, causality is logically definable; a real-world bipolar string theory is scalable, and an equilibrium-based minimal but most general axiomatization of physics, socioeconomics, and life sciences, as a partial solution to Hilbert's Problem 6, is logically provable.

It is shown that YinYang bipolar relativity is rich in predictions. Predictions are presented, some of which are expected to be falsifiable in the foreseeable future. In particular, it is shown that bipolar relativity provides the unified logical form for both gravity and quantum entanglement. It is conjectured that all forces in the universe are bipolar quantum entanglement in nature in large or small scales and in symmetrical or asymmetrical forms; the speed of gravity is not necessarily limited by the speed of light as it could well be limited by the speed of quantum entanglement.

Due to bipolar quantum entanglement, YinYang bipolar relativity leads to a logically complete theory for quantum computing with digital compatibility. The bipolar quantum computing paradigm is ideal for modeling non-linear bipolar dynamic oscillation and interaction such as non-local connection and particle-wave duality in quantum mechanics as well as self-negation/self-assertion abilities in cognitive informatics and competition-cooperation in socioeconomics. In particular, it is shown that bipolar quantum entanglement makes quantum teleportation theoretically possible without conventional communication between Bob and Alice. Furthermore, it is shown that bipolar quantum-digital compatibility and bitwise cryptography have the potential to make obsolete both prime number based encryption and quantum factorization.

Based on the logical foundation, limited mathematical construction is presented. Specifically, bipolar quantum linear algebra (BQLA) and YinYang-N-Element bipolar quantum cellular automata (BQCA) are introduced with illustrations in biosystem simulation and equilibrium-based global regulation. It is shown that the dimensional view, bipolar logical view, and YinYang-N-Element BQCA view are logically consistent. Therefore, bipolar set theory, bipolar dynamic logic, BQLA, bipolar agents, bipolar causality, and BQCA are all unified under YinYang bipolar relativity.

It is contended that YinYang bipolar relativity is an Eastern road toward quantum gravity. It is argued that it would be hard to imagine that quantum gravity as the grand unification of gravity and quantum

mechanics would not be the governing theory for all sciences. This argument leads to five sub-theories of quantum gravity: *physical quantum gravity, logical quantum gravity, social quantum gravity, biological quantum gravity, and mental quantum gravity that form a Q5 quantum computing paradigm*. The Q5 paradigm is then used as a vehicle to illustrate the ubiquitous effects of bipolar quantum entanglement that confronts us at every turn of our lives in comprehendible logical terms.

LIMITATIONS

Mathematically, the theory of YinYang bipolar relativity as a pure invention is not derived from general relativity or quantum theory. Instead, it presents a fundamentally different approach to quantum gravity. As a first step, the monograph is focused on the logical level of the theory and its applications in physical, social, brain, biological, and computing sciences with limited mathematical or algebraic extensions. Thus, equilibrium-based bipolar logical unification of gravity and quantum mechanics is within the scope of the book; the quantization of YinYang bipolar relativity and the mathematical unification of Einstein's equations of general relativity and that of quantum mechanics have to be left for future research efforts because *"For the time being we have to admit that we do not possess any general theoretical basis for physics which can be regarded as its logical foundation"* (Einstein 1940).

Theoretically, YinYang bipolar relativity presents an open-world and open-ended approach to science that is not *"a theory of everything."* In this approach, the author doesn't attempt to define the smallest fundamental element such as strings in string theory. Instead, it is postulated that YinYang bipolarity is the most fundamental property of the universe based on well-established observations in physical and social sciences. With the basic hypothesis, equilibrium-based logical constructions are developed with a number of predictions for experimental verification or falsification. This approach actually follows the principle of exploratory scientific knowledge discovery.

Practically, YinYang bipolar relativity is expected to be applicable wherever bipolar equilibrium or non-equilibrium is central (e.g. Zhang 2003a,b; Zhang 2006; Zhang, Pandurangi & Peace 2007; Zhang *et al.* 2010). As a quantum logic theory it is recoverable to Boolean logic and, therefore, is computational. As a relativity theory, its major role is to provide predictions and interpretations about nature, agents, and causality. Since it is not *"a theory of everything"*, it does not claim universal applicability. Simulated application examples are presented in quantum computing, cognitive informatics, and life sciences to illustrate the utility of the theory. The examples, however, are not intended to be systematic and comprehensive applications but only sufficient illustrations. While the theory is logically proven sound, predictions or interpretations made in the book can be either verified or falsified in the future, as usual.

CITING

References to others in this monograph are focused on important relevant works related to the logical foundation of this work. Since the formal system presented in the book is a free invention, not a philosophical elaboration of YinYang or an extension of other quantum gravity theories, references to YinYang literature are limited to the well-known basic concepts related to the logical foundation and references to relativity and quantum theory are limited to the basic concepts of spacetime geometry, particle physics, quantum entanglement, and teleportation. Selected references are mostly published scientific works in

peer reviewed books, journals, or conference proceedings. Non-peer reviewed Web articles cited are strictly limited to well-known historical facts or philosophical non-technical viewpoints. This treatment ensures that all technical references are from peer-reviewed scientific sources but undisputed well-known historical facts available online, and freely expressed, non-peer reviewed philosophical viewpoints published in the Web by related experts could be taken into account for readers' convenience.

SIGNIFICANCE

To the author's knowledge, this is the first monograph of its kind to introduce logically definable causality into physical and social sciences and to make the ubiquitous effects of quantum entanglement logically comprehendible. While Leibniz binary YinYang provided a technological basis for digital technologies, YinYang bipolar relativity is expected to bring quantum gravity into logical, physical, social, biological, and mental worlds for quantum computing.

The significance of YinYang bipolar relativity lies in its four equilibrium-based logical unifications: (1) the unification of unipolar positivist truth with bipolar holistic truth, (2) the unification of classical logic with quantum logic, (3) the unification of quantum entanglement with microscopic and macroscopic agent interaction in simple logical terms, and (4) the unification of general relativity with quantum mechanics under bipolar equilibrium and symmetry. Despite its limited mathematical depth, it is shown that YinYang bipolar relativity constitutes a deeper theory beyond spacetime geometry tailored for open-world open-ended exploratory knowledge discovery in all scientific fields where equilibrium and symmetry are central.

ORGANIZATION

The book consists of twelve chapters which can be roughly divided into the following five sections:

Part 1. Introduction and Background. This part consists of Chapter 1 and Chapter 2. Chapter 1 is an introduction; Chapter 2 is a background review.

Part 2. Set Theoretic Logical Foundation. This part consists of Chapters 3-5. This part lays out the set-theoretic logical foundation for bipolar relativity including YinYang bipolar sets, bipolar dynamic logic, bipolar quantum lattices, bipolar dynamic fuzzy logic, bipolar fuzzy sets and equilibrium relations.

Part 3. YinYang Bipolar Relativity and Quantum Computing. This part consists of Chapters 6-8 which are focused on the central theme of the book. Chapter 6 presents the theory of agents, causality, and YinYang bipolar relativity with a number of predictions. Chapter 7 presents bipolar quantum entanglement for quantum computing. Chapter 8 presents YinYang bipolar quantum linear algebra (BQLA), bipolar quantum cellular automata (BQCA), and a unifying view of YinYang bipolar relativity in logical, geometrical, algebraic, and physical terms.

Part 4. Applications. This part consists of Chapters 9-11. Chapter 9 is focused on biosystem simulation with BQLA and BQCA. Chapter 10 is focused on bipolar computational neuroscience and psychiatry. Chapter 11 is focused on bipolar cognitive mapping and decision analysis.

Part 5. Discussions and Conclusions. This part consists of the last chapter (Chapter 12) in which discussions and conclusions are presented.

CHAPTER OUTLINE

Chapter 1. Introduction: Beyond Spacetime

This chapter serves as an introduction to bring readers from spacetime relativity to YinYang bipolar relativity. Einstein's assertions regarding physics, logic, and theoretical invention are reviewed and his hint of YinYang bipolar relativity is identified. The limitations of general relativity and quantum mechanics are briefly discussed. It is concluded that logically definable causality, axiomatization of physics, axiomatization of agent interaction, and the grand unification of general relativity and quantum theory are essentially the same problem at the fundamental level. A paradox on Hilbert's Problem 6 – Logical Axiomatization for Illogical Physics (LAFIP) – is introduced. Bipolarity is postulated as the most fundamental property of nature transcending spacetime. The theoretical basis of agents, causality and YinYang bipolar relativity is highlighted and distinguished from established theories. The main ideas of the book are outlined.

Chapter 2. Background Review: Quest for Definable Causality

This chapter presents a review on the quest for logically definable causality. The limitation of observability and truth-based cognition is discussed. The student-teacher philosophical dispute between Aristotle and Plato is revisited. Aristotle's causality principle, David Hume's challenge, Lotfi Zadeh's *"Causality Is Undefinable"* conclusion, and Judea Pearl's probabilistic definability are reviewed. Niels Bohr's particle-wave complementarity principle, David Bohm's causal interpretation of quantum mechanics, and Sorkin's causal set program are discussed. Cognitive-map-based causal reasoning is briefly visited. YinYang bipolar logic and bipolar causality are previewed. Social construction and destruction in science are examined. It is asserted that, in order to continue its role as the doctrine of science, the logical definability of Aristotle's causality principle has become an ultimate dilemma of science. It is concluded that, in order to resolve the dilemma, a formal system with logically definable causality has to be developed, which has to be logical, physical, relativistic, and quantum in nature. The formal system has to be applicable in the microscopic world as well as in the macroscopic world, in the physical world as well as in the social world, in cognitive informatics as well as in life sciences, and, above all, it has to reveal the ubiquitous effects of quantum entanglement in simple comprehendible terms.

Chapter 3. Bipolar Sets and YinYang Bipolar Dynamic Logic (BDL)

In this chapter an equilibrium-based set-theoretic approach to mathematical abstraction and axiomatization is presented for resolving the LAFIP paradox (Ch. 1) and for enabling logically definable causality (Ch. 2). Bipolar set theory is formally presented, which leads to YinYang bipolar dynamic logic (BDL). BDL in zeroth-order, 1st-order, and modal forms are presented with four pairs of dynamic DeMorgan's laws and a bipolar universal modus ponens (BUMP). BUMP as a key element of BDL enables logically definable causality and quantum computing. Soundness and completeness of a bipolar axiomatization are asserted; computability is proved; computational complexity is analyzed. BDL can be considered a non-linear bipolar dynamic generalization of Boolean logic plus quantum entanglement. Despite its non-linear bipolar dynamic quantum property, it does not compromise the basic law of excluded middle. The recovery of BDL to Boolean logic is axiomatically proved through depolarization and the computability

of BDL is asserted. A redress on the ancient paradox of the liar is presented with a few observations on Gödel's incompleteness theorem. Based on BDL, bipolar relations, bipolar transitivity, and equilibrium relations are introduced. It is shown that a bipolar equilibrium relation can be a non-linear bipolar fusion of many equivalence relations. Thus, BDL provides a logical basis for YinYang bipolar relativity – an equilibrium-based axiomatization of social and physical sciences.

This chapter is based on ideas presented in (Zhang & Zhang 2003, 2004) (Zhang 2003a,b; 2005a,b; 2007; 2009a,b,c,d). Early works of this line of research can be found in (Zhang, Chen & Bezdek 1989) (Zhang *et al.* 1992) (Zhang, Wang & King 1994)

Chapter 4. Bipolar Quantum Lattices and Dynamic Triangular Norms

Bipolar quantum lattice (BQL) and dynamic triangular norms (t-norms) are presented in this chapter. BQLs are defined as special types of bipolar partially ordered sets or posets. It is shown that bipolar quantum entanglement is definable on BQLs. With the addition of fuzziness, BDL is extended to a bipolar dynamic fuzzy logic (BDFL). The essential part of BDFL consists of bipolar dynamic triangular norms (t-norms) and their co-norms which extend their truth-based counterparts from a static unipolar fuzzy lattice to a bipolar dynamic quantum lattice. BDFL has the advantage in dealing with uncertainties in bipolar dynamic environments. With bipolar quantum lattices (crisp or fuzzy), the concepts of bipolar symmetry and quasi-symmetry are defined which form a basis toward a logically complete quantum theory. The concepts of strict bipolarity, linearity, and integrity of BQLs are introduced. A recovery theorem is presented for the depolarization of any strict BQL to Boolean logic. The recovery theorem reinforces the computability of BDL or BDFL.

This chapter is based on the ideas presented in (Zhang & Zhang 2004) (Zhang 1996, 1998, 2003, 2005a,b, 2006a,b, 2007, 2009b). Early works of this line of research can be found in (Zhang, Chen & Bezdek 1989) (Zhang *et al.* 1992) (Zhang, Wang & King 1994)

Chapter 5. Bipolar Fuzzy Sets and Equilibrium Relations

Based on bipolar sets and quantum lattices, the concepts of bipolar fuzzy sets and equilibrium relations are presented in this chapter for bipolar fuzzy clustering, coordination, and global regulation. Related theorems are proved. Simulated application examples in multiagent macroeconomics are illustrated. Bipolar fuzzy sets and equilibrium relations provide a theoretical basis for cognitive-map-based bipolar decision, coordination, and global regulation.

This chapter is based on the ideas presented in (Zhang 2003a,b, 2005a,b, 2006a). Early works of this line of research can be found in (Zhang, Chen & Bezdek 1989) (Zhang *et al.* 1992) (Zhang, Wang & King 1994)

Chapter 6. Agents, Causality, and YinYang Bipolar Relativity

This chapter presents the theory of bipolar relativity – a central theme of this book. The concepts of YinYang bipolar agents, bipolar adaptivity, bipolar causality, bipolar strings, bipolar geometry, and bipolar relativity are logically defined. The unifying property of bipolar relativity is examined. Space and time emergence from YinYang bipolar geometry is proposed. Bipolar relativity provides a number of predictions. Some of them are domain dependent and some are domain independent. In particular, it

is conjectured that spacetime relativity, singularity, gravitation, electromagnetism, quantum mechanics, bioinformatics, neurodynamics, and socioeconomics are different phenomena of YinYang bipolar relativity; microscopic and macroscopic agent interactions in physics, socioeconomics, and life science are directly or indirectly caused by bipolar causality and regulated by bipolar relativity; all physical, social, mental, and biological action-reaction forces are fundamentally different forms of bipolar quantum entanglement in large or small scales; gravity is not necessarily limited by the speed of light; graviton does not necessarily exist.

This chapter is based on the ideas presented in (Zhang 2009a,b,c,d; Zhang 2010).

Chapter 7. YinYang Bipolar Quantum Entanglement: Toward a Logically Complete Theory for Quantum Computing and Communication

YinYang bipolar relativity leads to an equilibrium-based logically complete quantum theory which is presented and discussed in this chapter. It is shown that bipolar quantum entanglement and bipolar quantum computing bring bipolar relativity deeper into microscopic worlds. The concepts of bipolar qubit and YinYang bipolar complementarity are proposed and compared with Niels Bohr's particle-wave complementarity. Bipolar qubit box is compared with Schrödinger's cat box. Since bipolar quantum entanglement is fundamentally different from classical quantum theory (which is referred to as unipolar quantum theory in this book), the new approach provides bipolar quantum computing with the unique features: (1) it forms a key for equilibrium-based quantum controllability and quantum-digital compatibility; (2) it makes bipolar quantum teleportation theoretically possible for the first time without conventional communication between Alice and Bob; (3) it enables bitwise encryption without a large prime number that points to a different research direction of cryptography aimed at making prime-number-based cryptography and quantum factoring algorithm both obsolete; (4) it shows potential to bring quantum computing and communication closer to deterministic reality; (5) it leads to a unifying Q5 paradigm aimed at revealing the ubiquitous effects of bipolar quantum entanglement with the sub theories of logical, physical, mental, social, and biological quantum gravities and quantum computing.

This chapter is based on ideas presented in (Zhang 2003a, 2005a, Zhang 2009a,b,c,d; 2010).

Chapter 8. YinYang Bipolar Quantum Linear Algebra (BQLA) and Bipolar Quantum Cellular Automata (BQCA)

This chapter brings bipolar relativity from the logical and relational levels to the algebraic level. Following a brief review on traditional cellular automata and linear algebra, bipolar quantum linear algebra (BQLA) and bipolar quantum cellular automata (BQCA) are presented. Three families of YinYang-N-Element bipolar cellular networks (BCNs) are developed, compared, and analyzed; YinYang bipolar dynamic equations are derived for YinYang-N-Element BQCA. Global (system level) and local (element level) energy equilibrium and non-equilibrium conditions are established and axiomatically proved for all three families of cellular structures that lead to the concept of collective bipolar equilibrium-based adaptivity. The unifying nature of bipolar relativity in the context of BQCA is illustrated. The background independence nature of YinYang bipolar geometry is demonstrated with BQLA and BQCA. Under the unifying theory, it is shown that the bipolar dimensional view, cellular view, and bipolar interactive view are logically consistent. The algebraic trajectories of bipolar agents in YinYang bipolar geometry are illustrated with simulations. Bipolar cellular processes in cosmology, brain and life sciences are hypothesized and discussed.

This chapter is based on earlier chapters and the ideas presented in (Zhang 1996, 2005a, 200ba, Zhang 2009a,b,c,d, 2010; Zhang & Chen 2009; Zhang *et al.* 2009).

Chapter 9. Bipolar Quantum Bioeconomics for Biosystem Simulation and Regulation

As a continuation of Chapter 8, this chapter presents a theory of bipolar quantum bioeconomics (BQBE) with a focus on computer simulation and visualization of equilibrium, non-equilibrium, and oscillatory properties of YinYang-N-Element cellular network models for growing and degenerating biological processes. From a modern bioinformatics perspective, it provides a scientific basis for simulation and regulation in genomics, bioeconomics, metabolism, computational biology, aging, artificial intelligence, and biomedical engineering. It is also expected to serve as a mathematical basis for biosystem inspired socioeconomics, market analysis, business decision support, multiagent coordination and global regulation. From a holistic natural medicine perspective, diagnostic decision support in TCM is illustrated with the YinYang-5-Element bipolar cellular network; the potential of YinYang-N-Element BQCA in qigong, Chinese meridian system, and innate immunology is briefly discussed.

This chapter is based on earlier chapters and the ideas presented in (Zhang 1996, 2005a, 2006a, Zhang 2009a,b,c,d, 2010; Zhang & Chen 2009; Zhang *et al.* 2009).

Chapter 10. MentalSquares: An Equilibrium-Based Bipolar Support Vector Machine for Computational Psychiatry and Neurobiological Data Mining

While earlier chapters have focused on the logical, physical, and biological aspects of the Q5 paradigm, this chapter shifts focus to the mental aspect. MentalSquares (MSQs) − an equilibrium-based dimensional approach is presented for pattern classification and diagnostic analysis of bipolar disorders. While a support vector machine is defined in Hilbert space, MSQs can be considered a generic dimensional approach to support vector machinery for modeling mental balance and imbalance of two opposite but bipolar interactive poles. A MSQ is dimensional because its two opposite poles form a 2-dimensional background independent YinYang bipolar geometry from which a third dimension – equilibrium or non-equilibrium – is transcendental with mental fusion or mental separation measures. It is generic because any multidimensional mental equilibrium or non-equilibrium can be deconstructed into one or more bipolar equilibria which can then be represented as a mental square. Different MSQs are illustrated for bipolar disorder (BPD) classification and diagnostic analysis based on the concept of mental fusion and separation. It is shown that MSQs extend the traditional categorical standard classification of BPDs to a non-linear dynamic logical model while preserving all the properties of the standard; it supports both classification and visualization with qualitative and quantitative features; it serves as a scalable generic dimensional model in computational neuroscience for broader scientific discoveries; it has the cognitive simplicity for clinical and computer operability. From a broader perspective, the agent-oriented nature of MSQs provides a basis for multiagent data mining (Zhang & Zhang 2004) and cognitive informatics of brain and behaviors (Wang 2004).

This chapter is based on earlier chapters and the ideas presented in (Zhang 2007; Zhang, Pandurangi & Peace 2007; Zhang & Peace 2007)

Chapter 11. Bipolar Cognitive Mapping and Decision Analysis: A Bridge from Bioeconomics to Socioeconomics

The focus of this chapter is on cognitive mapping and cognitive-map-based (CM-based) decision analysis. This chapter builds a bridge from mental quantum gravity to social quantum gravity. It is shown that bipolar relativity, as an equilibrium-based unification of nature, agent and causality, is naturally the unification of quantum bioeconomics, brain dynamics, and socioeconomics as well. Simulated examples are used to illustrate the unification with cognitive mapping and CM-based multiagent decision, coordination, and global regulation in international relations.

This chapter is based on earlier chapters and the ideas presented in (Zhang, Chen & Bezdek 1989) (Zhang *et al.* 1992) (Zhang, Wang & King 1994) (Zhang & Zhang 2004) (Zhang 1996, 1998, 2003, 2005a,b, 2006a,b).

Chapter 12. Causality is Logically Definable: An Eastern Road toward Quantum Gravity

This is the conclusion chapter. Bertrand Russell's view on logic and mathematics is briefly reviewed. An enjoyable debate on bipolarity and isomorphism is presented. Some historical facts related to YinYang are discussed. Distinctions are drawn between BDL from established logical paradigms including Boolean logic, fuzzy logic, multiple-valued logic, truth-based dynamic logic, intuitionist logic, paraconsistent logic, and other systems. Some major comments from critics on related works are answered. A list of major research topics is enumerated. The ubiquitous effects of YinYang bipolar quantum entanglement are summarized. Limitations of this work are discussed. Some conclusions are drawn.

REFERENCES

Alford, D.M. (1993). *A report on the Fetzer Institute-sponsored dialogues between Western and indigenous scientists*. A presentation for the Annual Spring Meeting of the Society for the Anthropology of Consciousness, April 11, 1993. Retrieved from http://www.enformy.com/dma-b.htm

Bourbaki, N. (1998). *Elements of the history of Mathematics*. Berlin, Heidelberg, New York: Springer-Verlag.

Einstein, A. (1916). The foundation of the general theory of relativity. Originally published in Annalen der Physik (1916), *Collected Papers of Albert Einstein*, English Translation of Selected Texts, Translated by A. Engel, Vol. 6, (pp 146-200).

Einstein, A. (1934). On the method of theoretical Physics. *The Herbert Spencer lecture*, delivered at Oxford, June 10, 1933. Published in Mein Weltbild, Amsterdam: Querido Verlag.

Einstein, A. (1940). Considerations concerning the fundamentals of theoretical Physics. *Science, 2369*(91), 487-491.

Einstein, A., Podolsky, B. & Rosen N. (1935). *Can quantum-mechanical description of physical reality be considered complete? Physics Review, 47*, 777.

Fermi National Accelerator Laboratory. (2006). *Press Release 06-19*, September 25, 2006. Retrieved from http://www.fnal.gov/ pub/presspass/press_releases/CDF_meson.html

Hilbert, D. (1901). Mathematical problems. *Bulletin of the American Mathematics Society, 8*, 437-479.

Jacobsen, B.M. & Skalnik, D.G. (1999). YY1 binds five cis-elements and trans-activates the myeloid cell-restricted gp91phox promoter. *Journal of Biological Chemistry, 274*, 29984-29993.

Kandel, A. & Zhang, Y. (1998). Intrinsic mechanisms and application principles of general fuzzy logic through Yin-Yang analysis. *Information Science*, *106*(1), 87-104.

Karcher, S. (2002). *I Ching: The classic Chinese oracle of change: The first complete translation with concordance*. London: Vega Books.

Leibniz, G. (1703). *Explication de l'Arithmétique Binaire* (*Explanation of Binary Arithmetic*); Gerhardt, *Mathematical Writings* VII.223.

Martinez, A.A. (2006). *Negative math: How mathematical rules can be positively bent*. Princeton University Press.

MIT News. (2004). Yin/Yang Pavilion dedicated. Retrieved from http://web.mit.edu/newsoffice/2004/yinyang-0505.html

Overbye, D. (2006). A real flip-flopper, at 3 trillion times a second. *The New York Times – Science Report*. Retrieved from http://www.nytimes.com/2006/04/18/science/18find.html

Penrose, R. (2005). *The road to reality: A complete guide to the laws of the universe*. New York: Alfred A. Knopf.

Shi, Y., Seto, E., Chang, L.-S. & Shenk, T. (1991). Transcriptional repression by YY1, a human GLI-Kruppel-related protein, and relief of repression by adenovirus E1A protein. *Cell, 67*(2), 377-388.

Smolin, L. (2000). *Three road to quantum gravity.* Basic Books.

Smolin, L. (2006). *The trouble with physics: The rise of string theory, the fall of a science, and what comes next?* New York: Houghton Mifflin Harcourt.

Temple, R. (1986). *The genius of China: 3,000 years of science, discovery, and invention*. New York: Simon and Schuster.

The Royal Swedish Academy of Sciences. (2008). The Nobel Prize in Physics 2008. *Press Release*, 7 October. Retrieved from http://nobelprize.org/nobel_prizes/physics/laureates/2008/press.html

Wang, Y. (2004). On cognitive informatics. *Brain and Mind*, *4*(2), 151-167.

Woit, P. (2006). *Not even wrong: The failure of string theory and the search for unity in physical law.* New York: Basic Book.

Xu, L. (2007). Bayesian Ying Yang learning. *Scholarpedia, 2*(3), 1809. Retrieved from http://www.scholarpedia.org/article/Bayesian_Ying_Yang_learning

Zadeh, L.A. (2001). Causality is undefinable–toward a theory of hierarchical definability. *Proceedings of FUZZ-IEEE,* (pp. 67-68).

Zhang, W.-R., Chen, S. & Bezdek, J.C. (1989). POOL2: A generic system for cognitive map development and decision analysis. *IEEE Transactions on SMC*, *19*(1), 31-39.

Zhang, W.-R., Chen, S., Wang, W. & King, R. (1992). A cognitive map based approach to the coordination of distributed cooperative agents. *IEEE Transactions on SMC*, *22*(1), 103-114.

Zhang, W.-R., Wang, W. & King, R. (1994). An agent-oriented open system shell for distributed decision process modeling. *Journal of Organizational Computing*, *4*(2), 127-154.

Zhang, W.-R. (1996). NPN fuzzy sets and NPN qualitative algebra: A computational framework for bipolar cognitive modeling and multiagent decision analysis. *IEEE Transactions on SMC*, *16*, 561-574.

Zhang, W.-R. (1998). YinYang bipolar fuzzy sets. *Proceedings of IEEE World Congress on Computational Intelligence, Fuzz-IEEE*, (pp. 835-840). Anchorage, AK, May 1998.

Zhang W.-R. & Zhang, L. (2003). Soundness and completeness of a 4-valued bipolar logic. *International Journal on Multiple-Valued Logic*, *9*, 241-256.

Zhang, W.-R. (2003a). Equilibrium relations and bipolar cognitive mapping for online analytical processing with applications in international relations and strategic decision support. *IEEE Transactions on SMC, Part B, 33*(2), 295-307.

Zhang, W.-R. (2003b). Equilibrium energy and stability measures for bipolar decision and global regulation. *International Journal of fuzzy systems, 5*(2), 114-122.

Zhang, W.-R. & Zhang, L. (2004a). YinYang bipolar logic and bipolar fuzzy logic. *Information Sciences*, *165*(3-4), 265-287.

Zhang, W.-R. & Zhang, L. (2004b). A Multiagent Data Warehousing (MADWH) and Multiagent Data Mining (MADM) approach to brain modeling and NeuroFuzzy control. *Information Sciences, 167(1-4),* 109-127.

Zhang, W.-R. (2005a). YinYang bipolar lattices and L-sets for bipolar knowledge fusion, visualization, and decision making. *International Journal of Information Technology and Decision Making*, *4*(4), 621-645.

Zhang, W.-R. (2005b). YinYang bipolar cognition and bipolar cognitive mapping. *International Journal of Computational Cognition, 3*(3)*,* 53-65.

Zhang, W.-R. (2006a). YinYang bipolar fuzzy sets and fuzzy equilibrium relations for bipolar clustering, optimization, and global regulation. *International Journal of Information Technology and Decision Making*, *5*(1), 19-46.

Zhang, W.-R. (2006b). YinYang bipolar T-norms and T-conorms as granular neurological operators. *Proceedings of IEEE International Conference on Granular Computing*, (pp. 91-96). Atlanta, GA.

Zhang, W.-R (2007). YinYang bipolar universal modus ponens (bump)–a fundamental law of non-linear brain dynamics for emotional intelligence and mental health. *Walter J. Freeman Workshop on Nonlinear Brain Dynamics*, *Proceedings of the 10th Joint Conference of Information Sciences*, (pp. 89-95). Salt Lake City, Utah, July 2007.

Zhang, W.-R., Pandurangi, A. & Peace, K. (2007). YinYang dynamic neurobiological modeling and diagnostic analysis of major depressive and bipolar disorders. *IEEE Transactions on Biomedical Engineering, 54*(10), 1729-39.

Zhang, W.-R. & Peace, K.E. (2007). YinYang MentalSquares–an equilibrium-based system for bipolar neurobiological pattern classification and analysis. *Proceedings of IEEE BIBE*, (pp. 1240-1244). Boston, Oct. 2007.

Zhang, W.-R., Wang, P., Peace, K., Zhan, J. & Zhang, Y. (2008). On truth, uncertainty, equilibrium, and harmony–a taxonomy for YinYang scientific computing. *International Journal of New Mathematics and Natural Computing*, *4*(2), 207 – 229.

Zhang, W.-R, Zhang, H.J., Shi, Y. & Chen, S.S. (2009). Bipolar linear algebra and YinYang-N-Element cellular networks for equilibrium-based biosystem simulation and regulation. *Journal of Biological Systems*, *17*(4), 547-576.

Zhang, W.-R & Chen, S.S. (2009). Equilibrium and non-equilibrium modeling of YinYang WuXing for diagnostic decision analysis in traditional Chinese medicine. *International Journal of Information Technology and Decision Making, 8*(3)*,* 529-548.

Zhang, W.-R. (2009a). Six conjectures in quantum physics and computational neuroscience. *Proceedings of 3rd International Conference on Quantum, Nano and Micro Technologies (ICQNM 2009)*, (pp. 67-72). Cancun, Mexico, February 2009.

Zhang, W.-R. (2009b). YinYang Bipolar Dynamic Logic (BDL) and equilibrium-based computational neuroscience. *Proceedings of International Joint Conference on Neural Networks (IJCNN 2009)*, (pp. 3534-3541). Atlanta, GA, June 2009.

Zhang, W.-R. (2009c). YinYang bipolar relativity–a unifying theory of nature, agents, and life science. *Proceedings of International Joint Conference on Bioinformatics, Systems Biology and Intelligent Computing (IJCBS)*, (pp. 377-383). Shanghai, China, Aug. 2009.

Zhang, W.-R. (2009d). The logic of YinYang and the science of TCM–an Eastern road to the unification of nature, agents, and medicine. *International Journal of Functional Informatics and Personal Medicine (IJFIPM)*, *2*(3), 261–291.

Zhang, W.-R. (2010). YinYang bipolar quantum entanglement–toward a logically complete quantum theory. *Proceedings of the 4th International Conference on Quantum, Nano and Micro Technologies (ICQNM 2010)*, (pp. 77-82). February 2010, St. Maarten, Netherlands Antilles.

Zhang, W.-R., Pandurangi, K.A., Peace, K.E., Zhang, Y.-Q. & Zhao, Z. (2010). MentalSquares−a generic bipolar support vector machine for psychiatric disorder classification, diagnostic analysis and neurobiological data mining. *International Journal on Data Mining and Bioinformatics.*

Zhang, Y.-Q. (1992). Universal fundamental field theory and Golden Taichi. *Chinese Qigong, Special Issue 3,* 242-248. Retrieved from http://www.cs.gsu.edu/~cscyqz/ (in Chinese)