THANKS

Good morning. It is great honour to have been asked to present at such an important conference, to such a distinguished audience. In particular I would like to thank Professor Chung-ying Cheng for inviting me. My original academic background is in computation and formal logic and my research in the *Yijing* has largely focused on developing models of Change using the tools of contemporary mathematics. In this paper, I turn to discus some key ideas from physics and their relationship to the traditional metaphysics of Change.

OVERVIEW

In particular, during this talk, I shall explore the connection between the traditional ideas of *Wuji* and *Taiji* and the character of the quantum vacuum. This shows a strong connection between an empirically supported prediction of mathematical physics and a key metaphysical principle of the *Yijing*.

In the paper I also discuss the radical ideas of the physicist David Bohm. His suggestion for revising the underlying framework of physics based on holistic and holographic principles, what he calls the Implicate and Explicate orders, has a clear parallel with the traditional understanding of reality as being composed of the domains of Heaven and Earth, with the consciousness of humanity providing the key connecting principle.

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The psychologist Jung was deeply involved with the *Yijing*, and his idea of synchronicity is often advanced in western commentaries as a way of understanding the action of the spirit of Change in the world. Bohm's holistic physics provides a scientific framework that potentially allows us to make sense of synchronicity as a phenomenon with a reality beyond the purely psychological domain. The related, if controversial, idea of morphic resonance, due to Rupert Sheldrake, allows for the further possibility that the intent of an individual, as an integrated element in the continuum of existence, can influence the unfolding of events.

Combining all these ideas gives a way of understanding divination within the context of a scientific world view. In turn, accepting the validity of the act of divination tells us something about the kinds of scientific frameworks we should be looking for.

In this brief talk I shall only have time to discus the first of these connections.

TAIJITU SHOU

Let us briefly consider the traditional connection between *Wuji* and *Taiji* as characterized by the Song dynasty scholar Zhou Dunyi. In his explanation of the *Taiji* diagram this relationship is described by the phrase "wuiji er taiji" - which Adler translates as "non-polar and yet Supreme Polarity!" The two states are mysteriously interconnected, different and yet, in some sense the same. In turn, *Taiji*, the Supreme Polarity is described as being the origin of both *yin* and *yang*; through activity and stillness, it generates them both.

WUJI ER TAIJI

We can represent these relationships using a simple diagram.

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At the top is *wuji* – the empty circle of the unpolarized void. This is a state of emptiness, where nothing is differentiated.

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Emerging from the void is *taiji* – the spontaneous arising of the ultimate polarity from nothing. The two states *wuji* and *taiji* are connected by a double headed arrow graphically indicating their dynamic interconnection.

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Finally, the paired principles of *yin* and *yang* arise together from the alternating action of the supreme polarization.

So, with this classical metaphysical progression as our background, let us know turn to consider to some physics...

THE CLASSICAL VACUUM

...starting with the idea of the vacuum as it was understood in classical physics. What is the classical picture of the vacuum?

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It is simply nothing. Emptiness.

The classical vacuum is described as what ever is left when everything has been removed. In classical physics, if everything has been removed, then there is, by definition, nothing left.

But this is not the case in quantum physics. To understand the phenomenon of the quantum vacuum, we need to consider Heisenberg's uncertainty principle and its implication for empty space.

TIME AND HARMONICS (A)

A good example to help gain some insight into this principle comes from music.

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Consider the relationship between the timing of a musical note and its harmonic content. If a musical note is held for a long period, the precise time of its sounding cannot be accurately stated – instead, we can only say that it was sounding for a particular interval of time, between t1 and t2. In contrast, for such a note, we can very precisely measure its harmonic content.

TIME AND HARMONICS (B)

As the note becomes shorter and shorter it becomes possible to state more exactly when it sounded, because its interval becomes smaller. However, eventually the interval would become so small that the harmonics are eliminated and it would not be possible to determine the note's pitch, it would be heard simply as a click.

In fact, as soon as the interval of the note becomes shorter than the wavelength of the fundamental frequency, it becomes impossible to measure that frequency with any accuracy.

Therefore, the duration of a musical note and its harmonic content are not independent properties, measurement of one depends on the other.

HEISENBERG'S UNCERTAINTY PRINCIPLE

We can now consider uncertainty in the context of physics.

CLICK

Heisenberg's principle tells us that certain properties of physical objects such as particles, form complementary pairs. The properties within a pair cannot be considered independently.

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Specifically, the more accurately one property from a pair is measured, the less accurately it is possible, in principle, to measure the other. This is not a result of any technological difficulties with measurement, but is a fundamental limit our our ability to have knowledge of certain properties of the physical world and, it would seem, is a fundamental limit on the actual definiteness of values for those properties.

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One example of such a pair of complementary properties is the position of a particle and its momentum. The more accurately we know how much momentum a particle has, the less accurately we are able to know its position. Conversely, the more accurately we measure its position, the more uncertain we will be about its momentum.

This relationship is expressed mathematically by saying that the uncertainty about the position of the particle (represented by delta X in the equation) multiplied by the uncertainty about the momentum of the particle (delta P) must be greater than a particular constant value.

This constant is h (known as Plank's constant) divided by four pi. This is a very small value, but for a particle to be observable, the product of the uncertainty about its position and the uncertainty about its momentum must be larger than that value.

I'm not going to delve any deeper into the mathematics, but this has a major implication for apparently empty space. The more certain we are about the location of a point position in a region of space, the more uncertain we must be about the energy at that location. This means that the mathematics of quantum theory predicts that it is not possible to remove everything from a region of space. After all the particles have been removed from a region, the empty space itself is actually bubbling with an ineliminable amount of residual energy. This is sometimes called the zero-point energy of the vacuum.

This mathematical predication has been experimentally verified and measured. How does this fluctuating energy manifest? There are a variety of phenomena, but one way is in terms of virtual particle pairs.

THE QUANTUM VACUUM (A)

If the energy fluctuation at a particular point in the vacuum exceeds a sufficient threshold then there will be enough energy to allow a pair formed from a particle and its antiparticle to briefly come into existence.

That is, for example, out of nothingness, the energy fluctuation of the vacuum is momentarily sufficient to allow an electron and a positron appear. The pair only exist for a brief moment, too brief to be directly observable, and then they disappear again in mutual annihilation. In fact, the life time and energy of particles forms another Heisenberg pair, so the larger the uncertainty in the energy the shorter the uncertainty in the life time. Therefore, the more energy required to bring the particle pair into existence, the shorter the time span for which they can exist.

Such a pair of particles is called a “virtual pair” because they do not exist for long enough to be considered “real”.

In this animation we see an electron and a positron appear briefly from the energy fluctuation and then vanish in mutual annihilation again.

This gives a very different picture of the vacuum in quantum theory...

THE QUANTUM VACUUM (B)

As Barrow says: “the quantum vacuum can be viewed as a sea composed of all the elementary particles and their antiparticles constantly appearing and disappearing”.

THE QUANTUM VACUUM (C)

Therefore, I suggest that the properties of the quantum vacuum can be meaningfully described by the phrase *wuiji er taiji*.

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And the diagram representing this, showing *taiji* and *wuji* continuously exchanging, captures this phenomenon in a very direct way. *Wuji* is the quantum vacuum, which gives rise to *Taiji* – virtual particle pairs, in a spontaneous act of creativity.

CLICK

But the particle and its antiparticle which arise in this way are very tightly bound together. So tightly bound, and existing for such a short length of time that they cannot be directly detected, and cannot be said to have separate existence.

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So, in this picture, how do *yin* and *yang* arise and become separate? In terms of the physics, how do a virtual pair interact with the rest of reality?

VACUUM POLARIZATION (A)

There are number of different interactions that arise from the creation of virtual particle pairs. Here I'll describe an effect called vacuum polarization.

Instead of completely empty space, consider a region containing a single electron.

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This electron has a fixed electrical charge which can be accurately measured. If the vacuum was classical, empty, an electron in empty space would have its classically determined change.

CLICK

However, in the quantum vacuum virtual particle pairs are constantly emerging from and returning to nothing. As we saw earlier, in empty space those virtual pairs are tightly bound together. But when a pair of electrically charged particles arise something interesting happens.

Because of their charges, the virtual positron is attracted by the real electron and the virtual electron is repelled by the real electron. This creates a slight charge separation in the virtual pair which thereby reduces the measurable electric charge on the real electron.

Thus we see that the final aspect of the metaphysical interaction of *wuji*, *taiji* and *yin* and *yang* is also to be found within the picture presented by modern physics.

OLD AND NEW

In this brief presentation it has only been possible to scratch the surface of the connections between the thinking of the scholars of Change and the ideas of modern physics.

The traditional metaphysics of Change emerge from deep spiritual contemplation of the nature of the world and our place within it. The modern physics comes from abstract mathematical description and experimental verification of phenomena. I contend that the fact that it is possible to find such striking parallels between the traditional and modern descriptions lends significant weight to the assertion that there are profound connections between the content of spiritual insight and the fundamental nature of reality.

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Zhu Xi said that we should approach the old teaching in order to bring out new views.

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David Bohm said that what we have to do with regard to the great wisdom from the whole of the past, both in the east and in the west, is to assimilate it and to go on to a new and original perception relevant to our present condition of life.

I believe that the *Yijing*, both as a source of abstract philosophical study and as a practical tool for living provides an excellent method for generating, codifying, structuring and exploring original perception relevant to our present condition.

Thank you.