

Wave-Particle Duality in the 3rd Century BC?

Wave-particle duality leading to an advent of quantum mechanics in 300 BCE (300-201 year BC), sounds absurd does it not ? But take a look at this picture, the 'Yin-Yang' and you could give it another thought.



A (non) BRIEF HISTORY :

The *Yin –Yang* was one of the most intriguing and influential symbols, first found records of existing in the Han Dynasty (206 BC to 220 AD). The sole reason behind the mysticism and the intrigue surrounding it is the many possible interpretations that it has in the Chinese philosophy. In Taoist philosophy, the shade and light (☯) yin and yang, arrives in the *dàodéjīng*. It is impossible to talk about yin or yang without some reference of the opposite; since yin and yang are bound together as parts of a mutual whole (i.e. you cannot have the back of a hand without the front)...

We all might know about the principles behind the whole symbol as it “represents the ancient Chinese understanding of how things work. The outer circle represents "everything", while the black and white shapes within the circle represent the interaction of two energies called "yin" (black) and "yang" (white), which cause everything to happen in a dynamic system...

While "yin" would be dark, passive, downward, cold, contracting, and weak, "yang" would be bright, active, upward, hot, expanding, and strong.

The shape of the yin and yang sections of the symbol, actually gives you a sense of the continual movement of these two energies, yin to yang and yang to yin, causing everything to happen: just as things expand and contract, and temperature changes from hot to cold.”

They therefore define how the polar opposites or seemingly contrary forces and energies are interconnected and interdependent in the natural world, and how they give rise to each other in turn. Opposites thus only exist in relation to each other.

In the so-called *yin-yang wuxing* teaching, which was considered an “early Chinese attempt in the direction of working out metaphysics and a cosmology” (Chan 1963: 245)

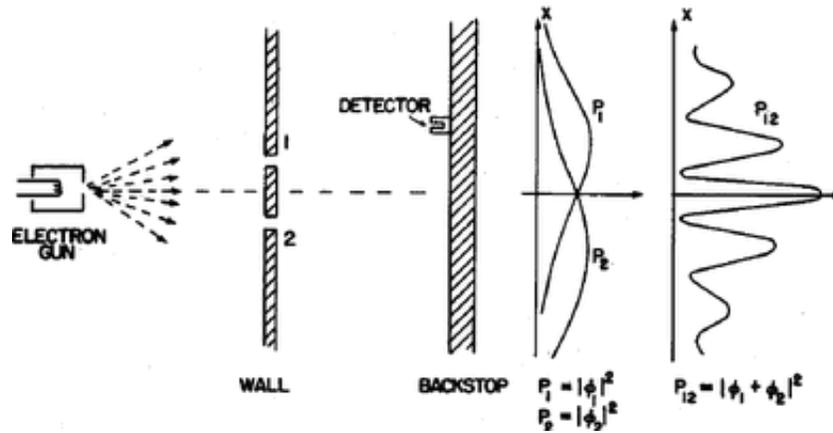
Now this *yin-yang*-favoured explanation claims to illuminate natural phenomena, to what extent is what surprises me, maybe from cosmology to quantum mechanics all answers hidden within this unassumingly artful symbol?

So now that we understand the origin of the *yin-yang* and the whole purpose of its creation. We could digress a little further.

THE WAVE-PARTICLE DUALITY:

Wave-particle duality in its essence means that every particle exhibits both wave and particle nature. In terms of its observable properties. The crux of the concepts behind the entire quantum mechanical theory.

Meanwhile this duality also points out the incapability of classical concepts of ‘particle’ and ‘wave’ to fully describe the behavior of quantum-scale objects. There are many interpretations to the understating of this paradox but yet it is accepted as a fundamental property of the Universe.



Electron Interference experiment : Wave functions of electrons superimpose to give an interference pattern.

Present accepted scientific theory holds that all particles also have a wave nature (and vice versa). This phenomenon has been verified not only for elementary particles, but also for compound particles like atoms and even molecules. For interference experiments including fullerenes and c-60 molecules as shown in the above figure.

Since every particle now has wave nature and every macro object consists of these quantum-scale objects, the same should be exhibited as wave nature of these macro objects. Therefore carrying this interpretation we could simply say that Louis-Victor de Broglie in 1924, extrapolated it further and formulated the de Broglie hypothesis, claiming that all matter and not just light, has a wave-like nature. He related wavelength (denoted as λ), and momentum (denoted as p) given in the equation:

$$\lambda = h / p$$

This having being proved time and again through experiments.

THE STRIKING CORRELATION:

One look at the *yin-yang* and you could see the corpuscular quantum 'particle' and it being embedded in a wave sort of character.

From the above interpretation of the data and a single look at the image we could derive that the particles namely the white dot in the black region and the black dot in the white region are clearly embedded in complementary coloured waves. Both particles being represented by their respectively coloured waves on the opposite side and they themselves stuck in the complementarily coloured wave. This is nothing but a distinctly clear representation of wave-particle duality.



Yin-Yang

To go on a little further we know that for particles their wave functions exists and a superposition of these wave functions can occur, just as it occurs in the interference experiments to give the interference patterns on the screen a shown above. This symbol has a similar depiction of the superposition of the two complementarily coloured waves as shown where the two waves merge into each other.

To know how much the Chinese were aware about the wave-particle duality depicted in the *yin-yang* is difficult to justify or comprehend as it is mentioned, that the Han dynasty chronicle "*Shiji (Records of the Historian)*" lists Zou Yan (305-240 BCE) "as a representative of the *yin-yang* school who possessed a profound knowledge of the theory of *yin-yang* and wrote about a hundred thousand words on it.

However, none of his works have survived...

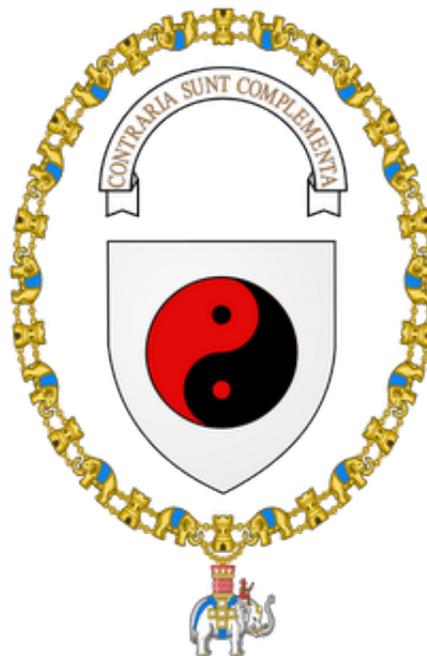
To remind people that Issac Newton had not worked on his corpuscular theory on light until the AD 1660's. Following a few centuries from there onto the advent of quantum mechanics. Wherein again in AD 1920's where Schrodinger and Heisenberg worked on the un solvable

problems in classical mechanics and Quantum mechanics (wave-particle duality) came to the rescue into solving them. It further becomes even more fascinating and captivating.



The super-position of wave functions

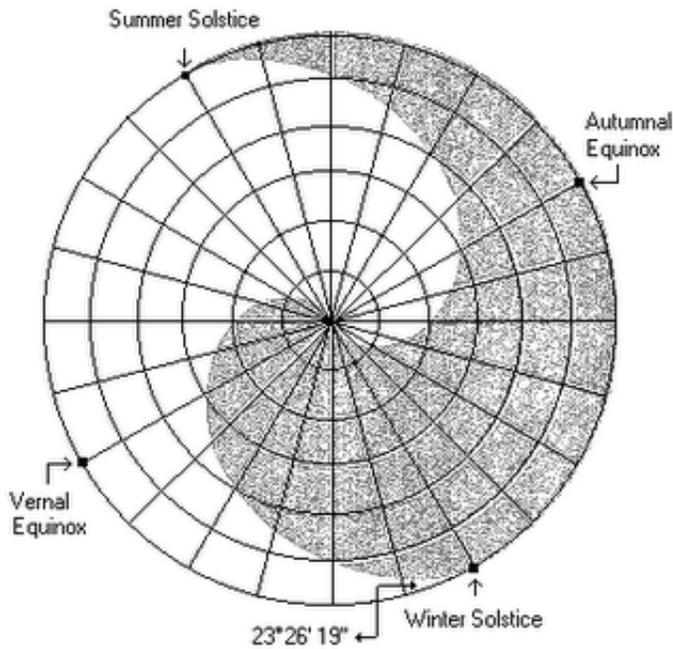
For people with a little more knowledge into the workings of quantum mechanics. To recollect: In the Born Interpretation, There is a ghost field (Gespensterfield) or a wave, guiding the corpuscular quantum but it shows the path for the momentum – energy carrier the light quanta. Comparable again to the depiction of the particle being supported by the wave it is embedded in.



To further bring in Bohr into the equation, who was one of the pioneers of the quantum theory as mentioned earlier. When awarded the Order of the Elephant by the Danish government, he designed his own “coat of arms” which featured a “taijitu” (symbol of yin and yang) and the motto in Latin: *contraria sunt complementa*: "opposites are complementary". The reason as to why he included the *yin-yang* except to depict the complementarity associated with the *yin-yang* in Quantum mechanics is hardly known.

COSMOLOGICAL ANALOGY

For the understanding the analogies behind the cosmological interpretation, I will leave you here with a few self explanatory images.



The entire celestial phenomenon. It contains the cycle of Sun, four seasons, 24-Segment Chi, the foundation of the I-Ching and the Chinese calendar.

IS there further more left to uncover, hidden within the 'yin-yang' ?