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Zero-Point Energy

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In the previous article we saw how the Golden Ratio **Φ** and the **ϖ** are fundamental numbers in the creation and evolution of natural formations. They appear in both live systems as well as non-alive systems. These two numbers, together with the speed of light are accepted to be nature's ***fundamental constants***. But are they really "constant"? They are irrational numbers, which means they cannot be expressed exactly as a fraction of two integer numbers. Furthermore, they are transcendental, which means that no finite sequence of algebraic operations can render their value. The ∏, for example, has been calculated precisely up to 5 trillion decimal digits and still no definite pattern of repeating numbers could be established. In other words both numbers have no end, which means that they are not "constants" in the real sense of the word.

The two roots of the equation $x^2 - x - 1 = 0$ are given in **14-The Golden Ratio**. Defining the two roots as Φ and φ we see that both are related to ∏ through:

$$\varpi = 4\,\mathrm{Arctan}(\Phi + \varphi)$$

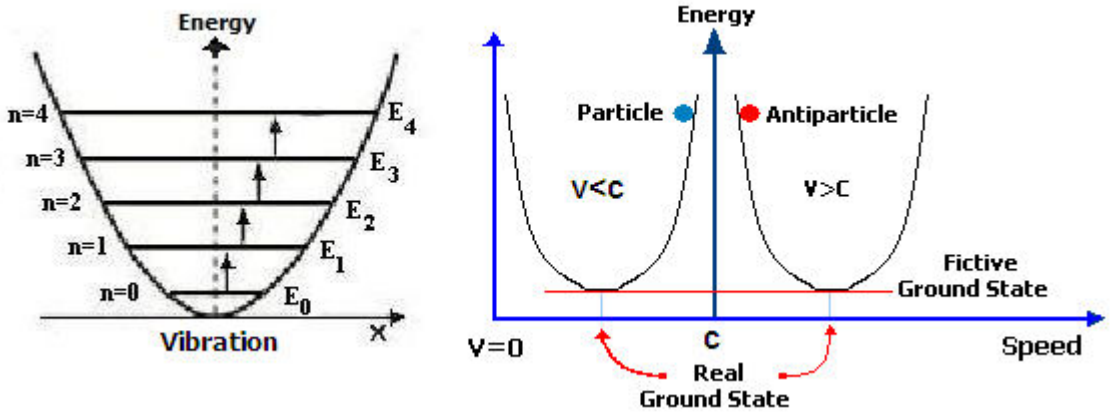
In nature nothing remains or exists totally at rest and no natural number is an absolute constant. This means that although we can approach very very near a certain natural "absolute value", we can never attain it practically. We saw in previous chapters that in order to speed a particle to the velocity of light we need an infinite amount of energy; a practical impossibility. The same is true for reaching the absolute zero degree Kelvin (-273 deg. C). Even the far distant empty space has a temperature about 2.7 degrees Kelvin.

In 1924 the Indian physicist Satyendra Bose developed a model regarding the behavior of photons (light particles) as a gas. He is honored as the namesake of the Boson, because bosons and the electromagnetic field have common features. His first paper on the subject was rejected by several scientific journals of the time. He finally sent his paper to Einstein who revised it and published it under both names. According to this paper, at very low temperatures matter will behave differently and a new phase (structure) would appear. This work led to a

new statistics known under the name of **Bose-Einstein Statistics** and a new phase of matter, known as the **Bose-Einstein Condensate**.

In 1995 two experimental physicists Eric Cornell and Carl Wieman could produce the first true Bose-Einstein condensate. They could cool Rubidium atoms to a temperature very near the absolute zero, approximately 100 Pico Kelvin (1 Pico degree is one billionth of a degree or 10^{-12} degree) above -273^0 C. Their work was awarded with the Nobel Prize on 2001.

Cooling atoms to very low temperature reduces their vibration and cause them to unite at their lowest possible energy state, or their Ground state. But we saw in article **5-The Coupled Universe** that even at their lowest possible energy state atoms do not remain totally at rest. In the figure below left we can see that the ground state E_0 is still above the absolute ground state.



The lowest allowed energy is called the **Zero-Point Energy**, because even atoms whose temperature is almost zero have this minimum energy. But at zero-point energy level, matter behaves differently. It becomes a conglomerate of interconnected waves that are neither solid, nor liquid, nor gas, but resembles a **condensate form of plasma**. This happens when the conglomerate of particles reach a critical point and behave as a single correlated entity. But the condensate is both a wave as it is a particle. It has been experimentally demonstrated that interference between condensates can happen due to the wave-particle duality of all existing entities.

Quantum physics predicts that all of space must be filled with electromagnetic zero-point fluctuations (also called the zero-point field) creating a universal sea of zero-point energy. This was explained in article **9-the Lattice Field**. The zero-point energy tells us that there cannot be a state in which the system sits motionless at the bottom of its potential well, for then its position and momentum would both be completely determined to arbitrarily great precision. This situation is in accordance with the **Heisenberg Uncertainty Principle**.

In the figure above right we see that it is impossible to bring a particle to a total rest. If one wants to reach a state where V=0 (this is to bring a particle to a total stop) we need to supply a lot of energy. This was the case when scientists wanted to create a Bose-Einstein condensate (BEC). They used a huge amount of

energy in order to create a tiny amount of BEC. Thus the second law of Thermodynamics is still valid. But according to my model, as the particle is slowed down and its speed approaches zero, its antiparticle has to speed up and reach an almost infinite speed. This means that the total energy of the particle-antiparticle pair is conserved. We can now reinterpret the definition of "rest mass" as the "fictive ground state mass", since no particle can totally be at rest.

An important question is: "What is the frequency of the quantum fluctuations?". Since energy E and frequency f are coupled through the Planck constant h (E=hf), calculating the frequency will give an approximate information on the zero-point energy. According to the Quantum Theory the zero-point energy is different than the Cosmic Microwave Background Radiation and is inversely proportional to the Planck time, which is $5.4x10^{-44}$ sec. Thus the Planck frequency becomes approximately 10^{43} Hz (vibrations per second). This represents an enormous potential source of energy with a density of as much as $\sim 10^{113}$ J/m^3 which is far in excess of any other known energy source even if only an infinitesimal fraction of it is accessible. This energy is so enormous that most physicists believe that it cannot be physically real, and so is subtracted away in calculations by ad hoc means (1).

A minority of physicists do, however, accept it as a real energy which we cannot detect since it is the same everywhere. Our bodies and measuring devices vibrate in unison at such high frequencies that makes it impossible for us to measure the quantum fluctuations of the universe. From this perspective, the universe is a vibrating unity whose frequency as well as its energy density is tremendously high. The present proposed model predicts that this is the case. At the speed of light as well as at total rest the energy density increases exponentially, as can be seen from the above graph. At the limit, particles and antiparticles unite in a single combined state. Thus, the present model is also the "theoretical proof" that the zero-point energy state can never be practically achieved. The present model is also in accordance with **Chaos Theory** that predicts the existence of a single "state" which bifurcated into two initial branches (see **11-Order and Disorder**).

(1) **Review of Experimental Concepts for Studying the Quantum Vacuum Field,** E. W. Davis et. Al.