Subject: Science

Article: 5

The Coupled Universes

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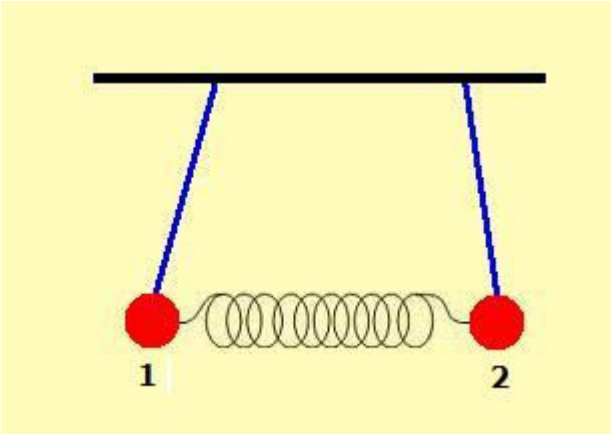
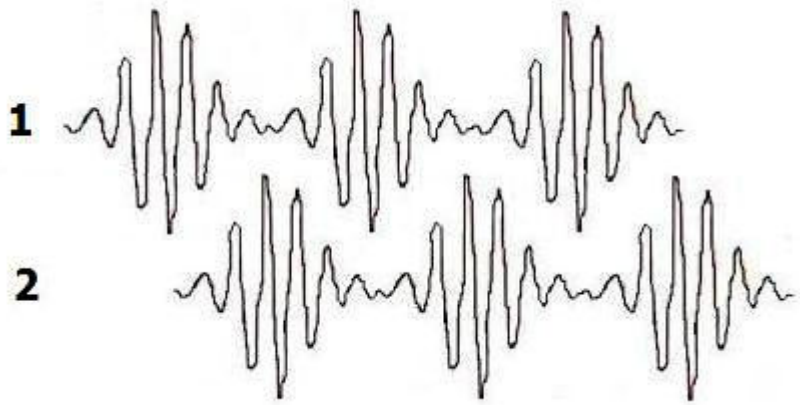
In the previous chapter we came to the conclusion that there exist two universes. One is our universe where the speed of light is the upper limit for any moving particle or wave, and the other one is the Tachyon universe where the speed of light is the lower limit. These two universes are both next to each other and also within each other. This is because, although particles and antiparticles do not interact, they are coupled to each other through a very weak coupling constant. Let us try to visualize this situation in our daily experience.



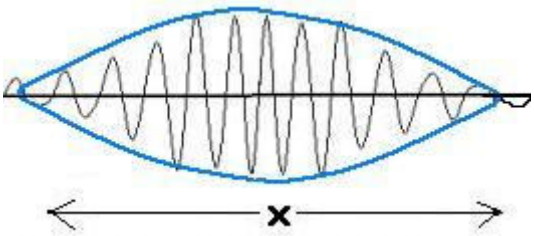
Consider two simple pendulums connected by a very weak spring as shown in the picture above. Let us assume that the pendulums 1 and 2 are "harmonic oscillators" vibrating with a rather high frequency. Although any initial condition is possible, let us assume that initially 1 is set to vibrate while 2 is at rest. Soon, 2 will start to swing under the influence of the spring, while the amplitude of 1 will decrease. If there is no friction to stop the system, the exchange of energy will continue ad infinitum and each pendulum will oscillate alternatively.

Below we see how these coupled vibrations of the pendulums (**harmonic oscillators**) will alternate in time.



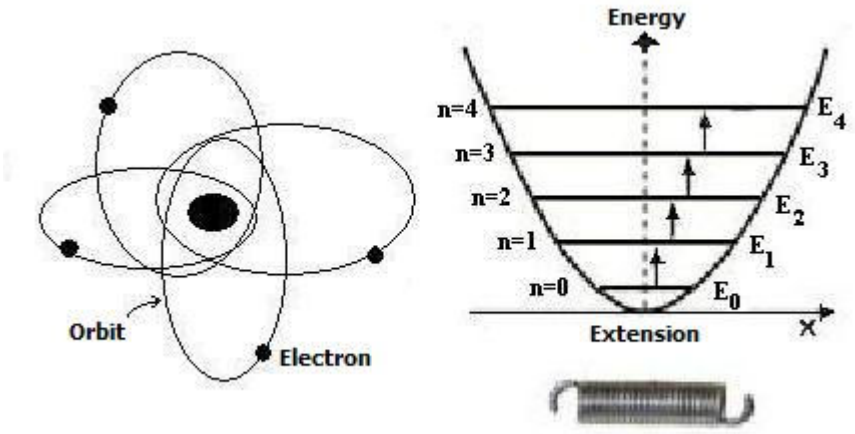
The harmonic oscillators are not independent and cannot oscillate by themselves. They need each other for sustained vibration, but cannot touch each other. If they touch or knock to each other, the spontaneous collision will stop the vibrations immediately. This is why particles and antiparticles cannot touch each other. Their annihilation into a couple of photons means that they approached their boundary which is the speed of light (see the graph in the previous chapter **4-Particles and Antiparticles**).

We are now able to grasp why the two universes are both separate as well as within each other. The particles and antiparticles are weakly coupled but they vibrate within their own separate energy field. Since the energy of these harmonic oscillators is quantized they can only vibrate in certain well defined frequencies. Each definite frequency corresponds to a discrete energy level, hence a discrete mass. In the micro scale the vibrating wave packet behaves like a localized particle as shown below. In fact all matter in our universe is both a wave as well as a particle. Depending on our setup we can observe the local energy condensation either as a wave or as a particle. Each wave packet has a certain extension in space. This extension, shown as x, can be considered as a normal mode of vibration of the quantized energy field.

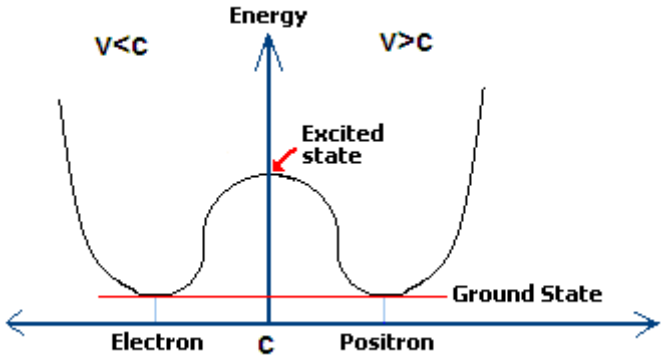


The normal modes of vibration of the quantized (discrete) energy field are similar to the energy levels of an atom. The electrons of any atom revolve around the nucleus in well defined orbits. Each orbit is quantized and the electrons do not jump from one orbit to the other under normal conditions. This is because the electron is also a wave that has a definite frequency depending in the orbit it has settled. Below we see on the left a model of an atom and on the right the discrete energy levels. If the atom is exited by an external agent, the electron will jump from one

orbit to another one. But in order that the atom continues to exist in its original form, the electron will jump back to its original orbit, ejecting a photon whose energy is equal to the energy it originally received.



The electron can be considered as a spring having discrete vibration modes. Each mode is equivalent to a given energy level E. At the normal vibration mode the electron is said to exist in the **ground state** E_0. This ground state is different than zero as can be seen. This is because the "rest mass" of the electron is different than zero. Since every electron is coupled to a positron, the potential energy defining the electron-positron pair has to be degenerate. Without going into mathematical details, the shape of the common **Potential Energy** is shown below.



We see that the energy of the electron-positron pair is higher than the energy of either the electron or the positron. Due to the inherent quantum fluctuations the excited state degenerates into two lower energy levels. This situation is called "**spontaneous symmetry breaking**" or "**bifurcation**". One branch of the bifurcation creates particles and the other branch antiparticles. Vibrations that move at the speed of light c, are massless waves but can behave like particles. All electromagnetic radiations (photons) as well as gravitons move with a fixed speed c, and their energy does not degenerate into lower energy states.