ABOUT THE "QUANTIZED" WORLD

What is the meaning of the term "quantum"? Planck´s merit is justified on his awareness on the fact that light (or electro-magnetic waves in general), is "quantized". How should we understand this? Imagine a torch with the help of which you "shoot" a ray of light into the darkness of the universe. How much energy does this ray of light contain? Everyone knows that we had to use the energy of a battery to "produce" the light wave. But how do we calculate the energy content of the light wave. Exactly this option of calculating the energy content of light and electro-magnetic waves in general is the merit of Max Planck´s work. It is important that we don´t have to imagine a light wave as continuum but as a wave consisting of many little "wave-packeges", so-called quanta (*lat. quantum "how big", "how much"*). So, how can we calculate the energy content of these small "wave packeges" (quanta)?

In order to explain the "radiation spectrum of a so-called "black body", Max Planck randomly encountered (as he stated himself: *…with a lucky hand…*) the so-called *Planck constant* (6,626070040 x 10^{-34} *Jouleseconds*, Js). Planck named this value "*help*" (h) as he was looking desperately for a helping "value" that could explain the radiation spectrum. The *Planck constant* is – as well as the *speed of light* and the *gravitational constant* – a universal constant. Due to this "*help*", it was possible to calculate the energy content of any wave length. For this he derived the following equation:

$$E = hf = h\frac{c}{\lambda}$$

(h Planck constant, c speed of light, f frequency *(cycles per second)*, λ wave length)

Let us imagine we had emitted the light of the torch in a with a wave length of 500 nanometers. This corresponds to a wave length of 500 billionth of a meter, thus, 0.0000005 meter. Our sun, for example, has its emission maximum in the range of 500 nanometers. If we plug this value into the equation (see above), we are able to calculate the energy content of a single wave packege (quant) with a wave length of 500 nanometers or a frequency of 6 • 10^{14} cycles per second. A quant with a wave length of 500nm, therefore, has, according Planck´s equation an energy content of **3.975… x 10^{-19} Joule.**

Interestingly, not only electromagnetic waves are quantized. Even distances, space and time are quantized. The shortest possible distance amounts to **1.616 x 10^{-35} m**. This disatnce is called Planck length l¬p, which can be calculated with help of the universal constant h **(Planck constant)**, C **(speed of light)** and G **(gravitational contant)**:

$$l_P = \sqrt{\frac{hG}{2\pi c^3}}$$

As space is determined by three distances (length, width, hight) there exists also a quant of space **(4.224 x 10^{-105} m3)**, called Planck volume:

$$l_P{}^3 = \sqrt{\frac{hG}{2\pi c^3}}^3$$

Furthermore, there is a quant of time, also called Planck time (**5.391 x 10^{-44} sec**):

$$t_P = \frac{l_P}{c}$$

As you can see, the whole world is quantized. Even space and time do not form a continuum but are quantized.

However, even a maximum possible wavelength exists in our universe.

The longest wave length is defined by the **maximum possible distance** within the universe. This can be calculated by means of the following equation:

$$\boldsymbol{D_U = \frac{c^2}{g_U}}$$

($\boldsymbol{D_U}$ corresponds to the longest possible distance between two locations in universe, $\boldsymbol{C}$ corresponds to the speed of light and $\boldsymbol{g_U}$corresponds to the gravitational potential of the universe)

With the help of this equation we are able to calculate the energy content of a quant with the maximum possible wavelength in the following way:

$$E = \frac{hc}{\lambda} \qquad \lambda_{\boldsymbol{max}} = \frac{c^2}{g_U}$$

From this it follows:

$$E_{\boldsymbol{max}} = \frac{hg_U}{\boldsymbol{C}}$$

There is also a maximum possible mass, the mass of the universe, which is clearly defined and calculable by means of the following equation:

$$\boldsymbol{M_U = \frac{c^4}{4G\,g_U}}$$

Even the maximum possible space, the space of our universe, is calculable with the help of the following equation:

$$V_U = \frac{\pi c^6}{6 g_U{}^3}$$

According to the last two equations, the mean density – and consequently the gravitational potential $\boldsymbol{g_U}$ of the universe – would be infinitely small if we assumed that the universe displayed an infinite volume and an infinitely large mass (in both equations gu is to be found in the denominator of the fractions). If we assumed an infinitely small gravitational potential $\boldsymbol{g_U}$ of the universe, the values for $\boldsymbol{M_U}$ and V_U would be infinitely large. This, however, would mean that galaxies, stars and planets could not exists, as the mean density of the universe was simply too small to allow concentration of matter. Such a universe would be as cold as ice allways and evermore. The temperature of an infinitely large universe would be - 273.15°C. Such a universe would be a dead universe and and not at all be able to generate any kind of life not even primitive amino acids. Life can only be generated within a universe that is limited in space and matter. The extent of the universe, thus, its volume, is clearly defined by its mass and vice versa. Mass and space of the universe are equivalent!

If we assume an unlimited mass and an unlimited space, thus, an unlimited entity, we have likewise to assume the existence of an unlimited number of universes. If we assume that life is the essential reason for existence, we have to state that there is an unlimited number of universes showing the same characterisics as our universe. To assume only one universe is as shortsighted as the archaic perception of only one sun, one earth and one “crown of creation” (us). Hence, our universe would merely be a “quantum of universe” out of many, or to put it this way, a Planck Universe out of indefinite Planck Universes.

This assumption is, of course, highly speculative, as it cannot be proven currently. However, this hypothesis arises from a simple logic and opens the door to an interesting perspective.