# The matter, the mass, the weight.

How long will the second take? Nearly 9 bilions periods of radiation of Caesium 133. And how long will one period of Cs 133 take? Nearly 1/9 000 000 000 sec. In other words one period will take one period. Our question has the same meaning as the question how long will take one day. We could know only the ratio of one day to one month or to one year or to periods of $Cs^{133}$.

From the chapters about units we know a new definition of the base unit for the mass. The old base unit was replaced by the new one. Let´s go to the old unit for the mass. The mass was defined as a protopype from an alloy of Platinum and Iridium. The alloy prototype replaced the cubic decimeter of the water.

O.K. Imagine the prototype is made only from Platinum. To make easy the next step. We have 1 kg of Platium as a base unit for the mass.

By the molality in 12 gr. of Carboneum $C^{12}$ there are 6,022 140 76 x $10^{23}$ atoms.

At the 195 gr. $Pt^{195}$ there are also 6,022 140 76 x $10^{23}$ atoms.

1000/195 = 5,128 2 .. . We ignore an evaporating or wearing. We must use the moll. How many atoms of $Pt^{195}$ are there in 1 kg?

At 1 kg (1000 gr) $Pt^{195}$ there are approximately 5,128 2 . 6,022 140 76 x $10^{23}$ = 3,088 x $10^{24}$ atoms. How many then is the mass of 1 atom of Pt? 1/3,088 x $10^{24}$ = 3,238 x $10^{-25}$ kg. In other words we can write the mass of 1 atom of Pt is equal to 1 atom of Pt. The same with other atoms. We only recognize the ratio of the mass among atoms of a periodic table. Let´s go for the new base unit for the mass. By using of a Planck constant. The Planck constant **h** were solved by using of the equation

$$\mathbf{h}=\frac{\mathbf{E}}{\mathbf{f}} \qquad \textbf{[1]}$$

where

**h** - the Planck constant $(6.62607015\times10^{-34})$ **J/s**

**E** - the thermal energy of a black body **J**

**f** - the frequency of radiated ELMG waves **1/s**

The Planck constant was fixed at the value $\mathbf{6.62607015\times10^{-34}}$ J/s. The same way as with the velocity of the light in 1983.

In other words the amount of a energy (or mass) depends on the frequency **f**. If we go up with energy then we obtain a larger frequency. The **h** is always same for the ratio **E** to **f**. We know the Planck equation in such form

$$E = h \cdot f \qquad [2]$$

We are able to solve the mass from the expression of Planck constant. Joule **(J)** means in base units **kg.m2/s2 .** After division of second **(s)** we obtain **kg.m2/s** . The second and the meter is defined. Now we are able to solve the mass. Of course with the help of a special Watt balance (or the Kibble balance).

What is the max. energy of 1 kg of any atoms or other subjects with some mass m? We use the equation

$$E = mc^2 \qquad [3]$$

where

**E** - the absolute energy **J**

**m -** the weight of the mass **kg**

**c -** the speed of the light in vacuum (299 792 458) **m/s**

from such equation we know the max. energy of 1 atom of Pt.

What is the energy of our universe? It depends how many there are of atoms, how many there are of photons of different ELMG wavelenghts and so on. And is the energy of our universe constant through the time? Don´t forget our universe is expanding. From a dark energy?

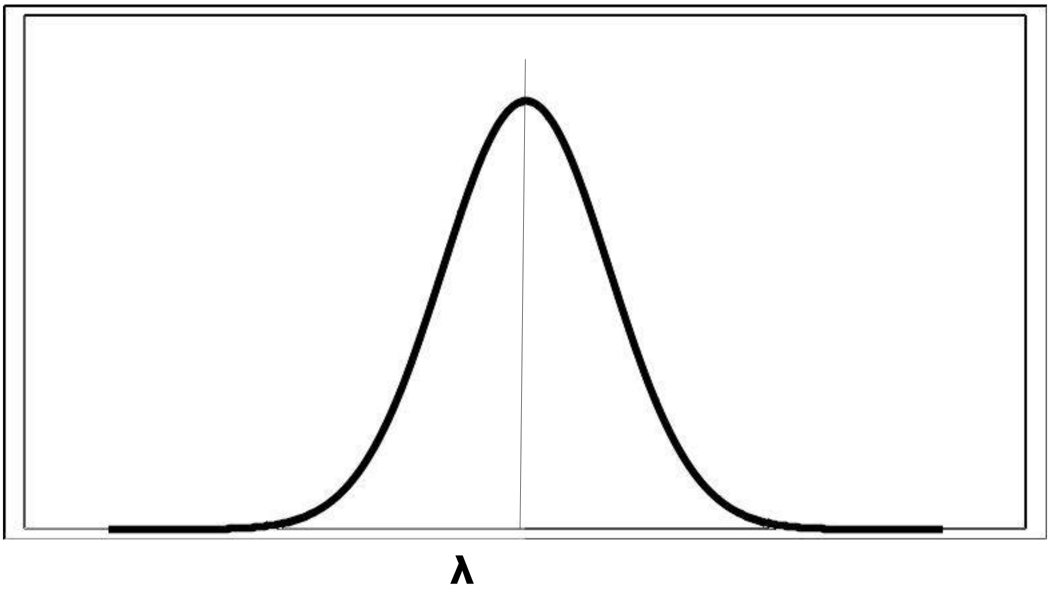
It´s quit good to get together the equations **[2]** and **[3]** with **E = E**

$$h \cdot f = mc^2 \qquad [4]$$

Now we are able to solve the mass of photons with some energy or to solve a frequency of waves of moving particles - see L.de Broglie.

What about the Planck constant. We must know

The size of Planck's constant has been fixed at a certain value. But it's good to know that this value has been taken from nature - the measurement of line spectra. In fact, we have not a sharp spectral line, but a probability profile of the spectral line. See the following (very well known to us) curve. The vertical axis is the intensity and the horizontal axis is the wavelength. We can clearly see that for a certain wavelength the intensity is maximum. The difference between the two base maximums is the base value of the Planck constant. See in Fig. 1 below.



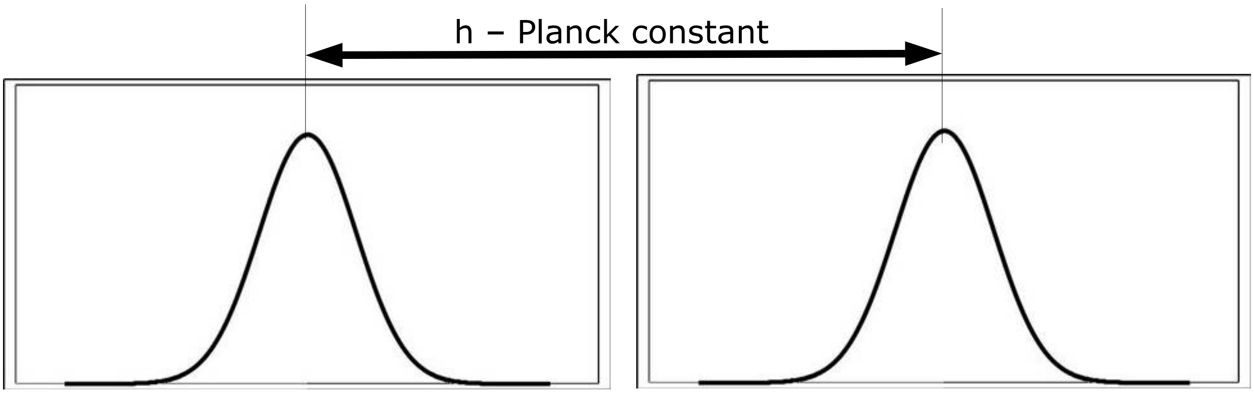


Fig. 1 - the Planck constant is „living" sometimes it's worth less, sometimes it's worth more. And all in a narrow probability distribution.

Let´s solve the „mass" of one photon of the radiation of $Cs^{133}$ with the frequency 9,192 GHz. Don´t mind about the structure of the photon. From eq. 4 we have got

$$\mathbf{m}=\frac{\mathbf{h}.\mathbf{f}}{\mathbf{c}^2} = \frac{6{,}626\,\mathbf{x}\,10^{-34}.\,9{,}192\,\mathbf{x}\,10^{9}}{299\,792\,458^{2}} = \mathbf{4{,}52\ x\ 10^{-41}\ kg} \qquad \mathbf{[5]}$$

Surely we can also find a frequency equivalent to one photon weighing 1 kg. A simple change in the equation **[5]** reveals that the frequency is equal 4,52 x $10^{41}$ Hz.

There's a big difference between high and low frequencies. A high frequency has more energy (mass) than a low frequency. See the photoelectric effect.