VACUUM ENERGY, DARK ENERGY
WITHIN THE FRAMEWORK OF THE THEORY OF CREATONS

1. Object of the article

The object of this article is to present the vacuum energy and the dark energy within the framework of the theory of the creatons, the vortex and the quantified waves and to explain the phenomenal difference between the two energies.

2. Phenomenal difference between vacuum energy and dark energy

The vacuum energy is an underlying energy which exists everywhere in space, through the Universe.
A possible contribution to the vacuum energy is realized by the virtual particles which are seen as couples of particles which appear and annihilate in a so short time length that they can't be observed. They would act so in the whole Universe. Their behaviour is codified in the time-energy relationship of the Heisenberg's uncertainty principle.

The effects of the vacuum energy can be experimentally observed in several phenomenons and are supposed to influence the behaviour of the Universe at the cosmological scale.

By using the superior limit of the cosmological constant, the vacuum energy has been estimated to **10^{-9} joules by cube meter.**

Whereas according to quantum electrodynamics and stochastic electrodynamics, to be coherent with Lorentz's invariant principle and the order of magnitude of Planck's constant, it should have a value of the order of **10^{113} joules by cube meter.**

This huge divergence is called the "vacuum catastrophe".

3. Vacuum energy according to the theory of the creatons

According to the theory of creatons, the "true vacuum" or "perfect vacuum" does not exist.
The creatons being everywhere in the Universe (and even beyond the visible Universe), a given volume, even intersidereal vacuum, still contains creatons.
The creatons constitute a field of creatons and form a medium called OMNIUM.

Let suppose that a cube meter of vacuum contains in average N_C creatons.

The main characteristic of a creaton is its speed of translation $\overrightarrow{V_C}$.

The energy of a unique creaton would be $E_C = k.\left\|\overrightarrow{V_C}\right\|^2$ where k is a constant of proportionality.

Important remark: in reality a creaton owns also a spin (a rotation movement around itself) which is essential to explain the gravitational force and the electromagnetic force, but this component doesn't add anything essential in the reasoning and would only complicate it unnecessarily.

The vacuum energy contained in one cube meter is so simply given by the following expression:

$$E_{vacuum} = E_{medium} = \sum_{i=1}^{N_C} E_C(i) = \sum_{i=1}^{N_C} k.\left\|\overrightarrow{V_C}(i)\right\|^2 = N_C.E_C = N_C k.V_C^2$$

where E_C is the average energy of a creaton and V_C the average speed of a creaton.

Remark : the chosen referential to measure the speed of the creatons has a negligible effect because it is moving at the fastest at the speed of light with regard to the Preferred Frame of Reference and the speed of the creatons is at least 10^{60} times the speed of light.

4. Dark energy according to the theory of the creatons

Within the framework of the theory of the creatons, the far galaxies are carried along by the medium which is the field of creatons and the speed of the galaxies corresponds to the average speed of the moving medium or field of creatons seen by an observer on Earth which is given by the following formula:

$$\overrightarrow{C_{C/Earth}} = \frac{\sum_{i=1}^{N_C} \overrightarrow{V_{C/Earth}}}{N_C}.$$

The dark energy would correspond to the dragging energy of the creatons contained in the medium.
Thus, the dark energy corresponding to one cube meter of medium, containing N_C creatons, would be given by the following formula:

$$E_{dark} = E_{CC} = N_C.k.\left\|\overrightarrow{C_{C/Earth}}\right\|^2.$$

This energy is also called E_{CC} because it corresponds to the energy due to the cosmological constant of the general relativity properly interpreted and assessed.

To determine the value of $\left\|\overrightarrow{C_{C/Earth}}\right\|$ we have to use Hubble's law $V = H.D$ which brings in the famous Hubble's constant H.

The current observations approximately match toward a value around 70 (km/s)/Mpc. This means that a galaxy located at 1 mega parsec (about 3.26 million light years) from the observer is going away by the fact of the expansion of the Universe (and thus without taking account the proper movement of the object, negligible at very high distances) with a speed of 70 km/s.

Le 21st of March 2013, the Planck mission allowed to calculate Hubble's constant, which is a recession speed : 67.8 kilometers per second and per mega parsec.

A galaxy located at D_{galaxy} = 13.7 billion light years is going away at a speed of:

$$V_{galaxy} = H.D = 67.8 \text{x} 4200 = 284760 km/s \quad \text{because}$$

$$D_{galaxy} = 13.7 \text{x} 10^9 AL = 13.7 \text{x} 10^9 \text{x} 9.46 \text{x} 10^{15} m = 1.296 \text{x} 10^{26} m = (13.7 \text{x} 10^9 / 3.2616 \text{x} 10^6) Mpc = 4200 Mpc$$

Remark: this speed is very close to the speed of light.

So, it is possible to make the following approximation: $\left\| \overrightarrow{C_{C/Earth}} \right\| \approx V_{galaxy} \approx c$.

5. Comparison between vacuum energy and dark energy

Doing the ratio between the vacuum energy and the dark energy, we find the very important relation:

$$\frac{E_{vacuum}}{E_{dark}} = \frac{V_C^2}{\left\| \overrightarrow{C_{C/Earth}} \right\|^2} .$$

This can provide us an estimation of the average speed of the creatons by taking:

$$\left\| \overrightarrow{C_{C/Earth}} \right\| \approx V_{galaxy} \approx c :$$

$$V_C = \left\| \overrightarrow{C_{C/Earth}} \right\| \sqrt{\frac{E_{vacuum}}{E_{dark}}} \approx V_{galaxy} \sqrt{\frac{E_{vacuum}}{E_{dark}}} \approx c \sqrt{\frac{E_{vacuum}}{E_{dark}}} .$$

The digital application gives : $V_C \approx 3.10^8 \sqrt{\dfrac{10^{113}}{10^{-9}}} \approx 3.10^{69} m/s$.

By another method described in the chapter 30 of the book « Theory of creatons, vortex and quantified waves » we had found:

$$V_C \approx \frac{R_{universe}}{T_{Planck}} \quad \text{which gives :} \quad V_C \approx \frac{13.7 \text{x} 10^9 AL}{5.4.10^{-44}} = 2.38 \text{x} 10^{69} m/s .$$

The two values of the average speed of the creatons obtained by two formulae totally different are with a good concordance.

Remark: it is possible to determine the product $N_C.k$ between the number of creatons contained in one cube meter "of vacuum" and the constant of proportionality k:

$$N_C.k = \frac{E_{vacuum}}{V_C^2} = \frac{10^{113}}{(3.10^{69})^2} \approx 10^{-26} J.m^{-2}.s^{-2} .$$

6. Analogy with a volume of gas or air

We consider a volume of gas or air and we suppose that this volume is pushed by a wind of speed V_G. It is possible to consider two types of energy associated with this volume of air:
- The "group energy" of the volume of air
- The energy of all the molecules composing the volume of air.

6.1 « Group energy » of the volume of air (analogy with dark energy)

The "group energy" of the volume of air is given by the following formula:

$$E_G = \frac{1}{2} M.V_G^2 = \frac{1}{2} N.m.V_G^2.$$

V_G represents the speed of the overall movement of the volume of air which is equal to the speed of the wind.
M represents the mass of the volume of air which is equal to N times the mass m of a molecule of gas where N represents the number of molecules of gas contained in the volume : M = N.m.

6.2 Energy of all the molecules contained in the volume of air (analogy with the vacuum energy)

The energy of the N molecules of mass m contained in the volume of air is given by the following formula:

$$E_{total} = \frac{1}{2} N.m.u^2.$$

u is the root-mean-square speed for which the kinetic theory of gases gives the following expression :

$$u = \sqrt{<v^2>} = \sqrt{3\frac{k_B.T}{m}} \ .$$

At ambient temperature (in spring around 300K), this speed can reach several thousands of meters per second and is much greater than the « group speed » of the volume of air.

Here again, the ratio between the two energies is equal to the square of the ratio of the two speeds.

7. Conclusion

The theory of creatons allows raising the mystery about the huge divergence between the vacuum energy and the dark energy called the "vacuum catastrophe".

Finally, about the acceleration of the galaxies moving away which corresponds to the accelerating expansion of the universe, this one is well understood within the frame of the theory of creatons because it is not due to a new force or repulsive energy but it is due to the same physical phenomenon which implies that matter is dragged by the field of creatons, the "dragging speed" being obtained by the vector mean of the speed of the creatons coming from all the directions comprising from the outside of the visible Universe.

It seems quite natural that the fundamental vector mean $\overrightarrow{C_C} = \dfrac{\sum\limits_{i=1}^{N_C} \overrightarrow{V_C}}{N_C}$ where the contribution of all

the creatons counterbalance, may vary along the time and the expansion of the Universe, in particular by increasing.