Revisited String Theory

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Abstract

In this short communication we give an experimental verification of the String Theory.

1.What is string theory?:

According to Gabriele Veneziano the String Theory is "the assumption that all truly elementary particles, rather than being point like, are instead one-dimensional objects: strings"[1]. With this model of particles we can avoid singularities when they interact.

At the quantum level a specific length is associated to any massive particle (the Compton wavelength):

$$\lambda_C = \frac{h}{mc} \qquad (1)$$

Where : $h = 6.626196\ 10^{-34}\ joule\ second$: Planck constant;

$c = 2.997924562\ 10^{8}\ meter/second$: speed of light in vacuum

m: mass of the corpuscle.

In string theory there is only one parameter the string tension F which play the role of the mass of the corpuscle. This tension is the energy per unit length of the string. We can also associate to the corpuscle the string length as [2]:

$$\lambda_S = \sqrt{\frac{hc}{F}} \qquad (2)$$

At the deepest level of quantum theory there is only a single F_0 for all possible strings and so this tension correspond to a fundamental inertia ξ_0 which is the basic building block of matter as the Compton wavelength will be a superposition of many fundamental strings λ_0 as:

$$\lambda_0 = \frac{h}{\xi_0 c} \qquad (3)$$

And in this level we will have:

$$\frac{h}{\xi_0 c} = \sqrt{\frac{hc}{F_0}} \qquad (4)$$

ξ_0 & F_0 : are universal constants.

The following steps will be to determine the constants ξ_0 & F_0 in a classic space time (Minkowski space time) and probably to connect this theory with the theory of gravitation.

Quantum strings acquire through quantum mechanics a characteristic size that permit to the string to respect the principle of uncertainty because a very large size costs a lot of energy and a small size implies a very large momentum which allow us to resolve problems in classical mechanics dealing with short distances without any singularities(quantization will enter at work).

A string is a superposition of many universal strings $\lambda_0 = \frac{c}{\nu_0}$ in a certain volume to give them density. So in vacuum those universal strings can be the base to estimate the value of vacuum energy density by statistical manner.

2-Vacuum Energy:

In a quasi-flat space time we can consider the energy $h\nu_0 = \xi_0 c^2$ as an optimum energy for all electromagnetic oscillators in their fundamental states: it is like a temperature of a radiation in a cavity considered as a black body. Than Planck model for black body radiation can be also useful as a model for vacuum energy density with a mean energy of the oscillator at low frequencies to be equal to about $\frac{1}{2}h\nu_0$ where ν_0 is an universal constant. The mean energy of the oscillator will be defined by analogy to Planck model of black body radiation as:

$$U = \frac{\sum_{n=0}^{n=\infty}\frac{n}{2}h\nu.exp(\frac{-\frac{n}{2}h\nu}{\frac{1}{2}h\nu_0})}{\sum_{n=0}^{n=\infty}exp(\frac{-\frac{n}{2}h\nu}{\frac{1}{2}h\nu_0})} = \frac{\frac{1}{2}h\nu}{exp\left(\frac{\nu}{\nu_0}\right)-1} \approx \frac{1}{2}h\nu_0 \; if \; \nu \ll \nu_0 \qquad (5)$$

The total energy density of the vacuum is then according to the model of the black body theory:

$$U_0 = \int_0^\infty \frac{8\pi\nu^2}{c^3}.Ud\nu = \int_0^\infty \frac{4\pi h}{c^3}.\frac{\nu^3}{exp\left(\frac{\nu}{\nu_0}\right)-1}d\nu = \frac{4\pi^5 h}{15.c^3}.\nu_0^4 \qquad (6)$$

The energy density of vacuum as given by General Relativity is as follows[3] :

$$U_0 = \frac{\Lambda.c^4}{8\pi G} \approx 10^{-9}Joule.m^{-3} \qquad (7)$$

With :

$\Lambda = 1.088\ 10^{-52}m^{-2}$: Cosmological constant;

$c = 2.997924562\ \ 10^8 m.s^{-1}$: Light celerity in vacuum;

$G = 6.67\ \ 10^{-11}\ SI\ units$: Gravitationnel constant ;

Equating (6) & (7) we get:

$$\nu_0 = \left[\frac{15\Lambda.c^7}{32.\pi^6 G.h}\right]^{\frac{1}{4}} \approx 0.7149\ 10^{12} Hz \qquad (8)$$

It is an infra red frequency which means that Universe is quasi-flat.

Universe is also considered as black body at a temperature $T = 2.7\ K$. If we consider the fundamental blocks of matter as a perfect gas filling the Universe than this "atom or molecule" of this gas will have an energy equal to $\frac{1}{2} k_B T$ along one space direction.

Considering the Universe as having $D - space\ directions$ than:

$$h\nu_0 = \frac{D}{2} k_B T \qquad (9)$$

With $k_B = 1.38\ 10^{-23}\ Joule\ Kelvin$: Boltzmann constant ;

It comes that:

$$D = \frac{2h\nu_0}{k_B T} = \frac{2x6.626196\ \ 10^{-34}x0.7149\ 10^{12}}{1.38\ 10^{-23}x2.7} = 25.43\ \approx 26 \qquad (10)$$

It is the same number of space dimensions predicted by String Theory in a quasi flat space-time (Minkowski space-time) [4], for a Universe filled with a perfect gas of bosons particles having the energy $h\nu_0$.

By taking $D = 26$ in equation (9) and going back we can determine all the other universal constants. This is an experimental verification of the coherence of the String Theory. For the Universe we can say that there is no big bang , not a pre-big bang but only a separation and agglomeration of the basic blocks of matter which gives us elementary particles, atoms, molecules , black holes , planets & galaxies.

References:

[1]Gabriele Veneziano "String theory: physics or metaphysics?", https://cds.cern.ch/record/2003211/files/Issue13_Paper_Veneziano.pdf

[2] Gabriele Veneziano "String theory and pre-bang cosmology" hep-th/0703055

[3] M. P. Hobson, G. P. Efstathiou and A. N. Lasenby 2006 "General Relativity" page187 , Cambridge University.https://wigner.hu/~barta/GRcourse2020/Hobson%20M.P.,%20Efstathiou%20G.P.,%20Lasenby%20A.N.%20-%20GR%20-%20An%20Introduction%20for%20Physicists(Cambridge,2006).pdf

[4]Hong Liu "MIT Physics 8.251: String Theory" page 80-86 , https://web.stanford.edu/~lindrew/8.251.pdf