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Expanding Universe at Almost Luminal Speed

Janez Špringer*

Cankarjeva cesta 2, 9250 Gornja Radgona, Slovenia, EU

Corresponding Author:** ***Janez Špringer, *Cankarjeva cesta 2, 9250 Gornja Radgona, Slovenia, EU*

Abstract: *The expanding of universe at almost luminal speed has been discussed.*

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1. Introduction

In the previous paper [1] the occurrence of universe was proposed at a low speed of expansion related to the kinetic energy of expansion:

$$W = \frac{m}{2} v^2. \tag{1}$$

Let us see what happens at higher speeds of expansion related to the relativistic kinetic energy of expansion which keeping the similar form of equation (1) can be expressed with the help of modified exponent $x \geq 2$ as follows (See Appendix):

$$W = \frac{m}{2} v^{x \geq 2}. \tag{2}$$

Where $x \geq 2$ being proportional to speed. Starting with $x = 2$ for $v = 0$ and still remaining $x \approx 2$ for $v << c$ but gaining higher values approaching closer and closer to the luminal speed c.

2. The Speed of Expansion

The speed of expanding n-dimensional universe $v(n)$ is determined by the speed of expanding 1-dimensional universe $v(1)$ divided by n dimensions [1]:

$$v(n) = \frac{v(1)}{n}. \tag{3}$$

3. The Relativistic Kinetic Energy of Expansion

Applying equation (3) the relativistic kinetic energy of expansion (2) can be expressed as:

$$W(n) = \frac{m}{2} \frac{(v(1))^x}{n^x}. \tag{4}$$

Where in each specific case the modified exponent x should be adapted to the new speed v (See Appendix).

4. The Occurrence of Expanding N-Dimensional Universe

The occurrence of expanding n-dimensional universe $p_x(n)$ depends on the kinetic energy of expansion. [1] The higher kinetic energy per dimension available the higher occurrence expected. Applying equation (4) the next occurrence is given:

$$p_x(n) = \frac{W(n)}{\sum_{n=1}^{n=\infty} W(n)} = \frac{\frac{m}{2} \frac{(v(1))^x}{n^x}}{\frac{m}{2} (v(1))^x \sum_{n=1}^{n=\infty} \frac{1}{n^x}} = \frac{1}{n^x} \frac{1}{\sum_{n=1}^{n=\infty} \frac{1}{n^x}} = \frac{p_x(1)}{n^x}. \tag{5a}$$

According to relation (5a) the occurrence of the expanding universe $p_x(n)$ depends on the number of dimensions n and the modified exponent x due to the increased speed as follows:

$$p_x(n) = \frac{p_x(1)}{n^x}. \tag{5b}$$

Where the number of dimensions n equals the ratio of speeds of the expanding one- and n-dimensional universe (3):

$$n = \frac{v(1)}{v(n)}. \tag{6}$$

And for the range of modified exponents $\infty \geq x \geq 2$ holds the next range of occurrences of 1-dimensional universe $p_x(1)$:

$$1 \geq p_x(1) = \frac{1}{\sum_{n=1}^{n=\infty} \frac{1}{n^x}} \geq \frac{6}{\pi^2}. \tag{7}$$

The above statement can be summarized from the following results that converge to unity with increasing speed of expansion manifested by the modified exponent *x* [2],[3]:

a) For x=2: $\sum_{n=1}^{n=\infty} \frac{1}{n^2} = \frac{\pi^2}{6} = 1.6449$ yielding $p_2(1) = \frac{6}{\pi^2} = 0.6079$

b) For x=4: $\sum_{n=1}^{n=\infty} \frac{1}{n^4} = \frac{\pi^4}{90} = 1.0823$ yielding $p_4(1) = \frac{90}{\pi^4} = 0.9239$

c) For x=6: $\sum_{n=1}^{n=\infty} \frac{1}{n^6} = \frac{\pi^6}{945} = 1.0173$ yielding $p_6(1) = \frac{945}{\pi^6} = 0.9830$

d) For x=8: $\sum_{n=1}^{n=\infty} \frac{1}{n^8} = \frac{\pi^8}{9450} = 1.0041$ yielding $p_8(1) = \frac{9450}{\pi^8} = 0.9959$

Expecting

e) For x=∞: $\sum_{n=1}^{n=\infty} \frac{1}{n^\infty} = \frac{\pi^\infty}{\pi^\infty} = 1$ yielding $p_\infty(1) = 1$.

For instance, some occurrences of expanding n-dimensional universe $p_x(n) = \frac{p_x(1)}{n^x}$ are collected in Table 1.

Table1. *The occurrences of expanding n-dimensional universe $p_x(n) = \frac{p_x(1)}{n^x}$ for n=1, n=2, n=3 and n=4 at the modified exponents x=2, x=2.5, x=3 and x=∞.*

$p_x(n) = \frac{p_x(1)}{n^x}$	n=1	n=2	**n=3**	n=4
$x = 2$	0.6079	0.1520	0.0675	0.0380
$\boldsymbol{x = 2.5}$	0.7199	0.1273	**0.0462**	0.0225
x = 3	0.8319	0.1040	0.0308	0.0130
…	…	…	…	…
$x = \infty$	1	0	0	0

The occurrence value of $p_3(1) = 0.8319$ is calculated with the help of equation (7) and reference [4]. And that one of $p_{2,5}(1) = 0.7199$ is estimated by the interpolation of values $p_2(1)$ and $p_3(1)$. It can be seen from Table1 that with the increasing speed of expansion expressed by the higher modified exponent x the occurrence of 1-dimensional universe $p_x(n = 1)$ becomes more favourable and consequently the occurrence of more than 1-dimensional universe $p_x(n > 1)$ is less likely. Obeying Einsteinian relativistic kinetic energy the universe should occupy only 1-dimensional space at luminal speed due to the infinitely modified exponent $x = \infty$ on this occasion, of course, if infinite energy required for it could be available. However, we almost touch the speed of light with a modified exponent of only $x = 2.5$ yielding $v = 0.999\,999\,993\,c$ (See Appendix). Further it provides at least 4.6% occurrence of 3-dimensional space. And the latter coincides with the occurrence of baryonic matter [5].

5. Conclusion

Let the light in

Dedication

To the Day of Light

Figure1. *Light [6]*

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APPENDIX

For relativistic kinetic energy holds [7]

$$W = m\frac{v^x}{2} = mc^2\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right). \qquad (a)$$

Or explicitly for v^x

$$v^x = 2c^2\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right). \qquad (b)$$

And explicitly for x

$$x = \frac{ln(2c^2) + ln\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right)}{lnv}. \qquad (c)$$

Replacing $v = ac$ we have

$$x = \frac{ln(2c^2) + ln\left(\frac{1}{\sqrt{1-a^2}} - 1\right)}{lnac}. \qquad (d)$$

Near the luminal speed we can take advantage of the fact that $a \approx 1$ to simplify the denominator

$$x \approx \frac{ln2 + 2lnc + ln\left(\frac{1}{\sqrt{1-a^2}} - 1\right)}{lnc}. \qquad (e)$$

And express the relation explicitly for a

$$a \approx \sqrt{1-\left(\frac{1}{e^{(x-2)lnc-ln2}+1}\right)^2}. \qquad (f)$$

What for example for the modified exponent $x = 2.5$ and $c = 299\,792\,458\ m/s$ yields

$$a \approx \sqrt{1 - \left(\frac{1}{e^{9.066\,153} + 1}\right)^2} = 0.999\,999\,993\ and\ v = 299\,792\,456\,\frac{m}{s}. \qquad (g)$$

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