1: Cosmological constant via Planck Black-hole Universe Simulation Hypothesis

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The Simulation Hypothesis proposes that all of reality is in fact an artificial simulation, analogous to a computer simulation. Outlined here is a method for constructing principal cosmic microwave background parameters applicable to a Simulation Hypothesis, the only variable required being the universe age as measured in units of Planck time, in a Planck-level simulation. The model uses micro Planck-size black holes that embody the Planck units. The simulation begins as a single micro black-hole and expands by adding further micro black-holes in incremental steps; these steps as the simulation clock-rate and the origin of Planck time. As the sum black-hole 'grows' accordingly in size and mass a dark energy is not required, the simulation could however include an inverse contracting white-hole twin as the source of the micro black-holes, by this mechanism upon reaching near absolute zero the roles can then exchange and the black-hole then becomes the contracting white hole ad infinitum. The mass-space parameters increment linearly, the electric parameters in a sqrt-progression, thus for electric parameters the early black-hole transforms most rapidly. The velocity of expansion is constant and is the origin of the speed of light, the Hubble constant becomes a measure of the black-hole radius and the CMB radiation energy density correlates to the Casimir force. A peak frequency of 160.2GHz is used as the simulation age benchmark and gives a 14.624 billion year old (Planck) black-hole. The cosmological constant, being the age when the sum black-hole can expand no further, is estimated at $t = 10^{123} t_p$ (from the simulation start) via temperature and $t = 10^{108} t_p$ via radiation energy density.

Table 1	Black-hole [2]	Cosmic microwave background
Age (billions of years)	14.624	13.8 [5]
Age (units of Planck time)	0.4281 x 10^{61}	
Cold dark matter density	0.21 x $10^{-26} kg.m^{-3}$ (eq.1)	0.24 x $10^{-26} kg.m^{-3}$ [7]
Radiation energy density	0.417 x $10^{-13} kg.m^{-3}$ (eq.10)	0.417 x $10^{-13} kg.m^{-3}$ [5]
Hubble constant	66.86 km/s/Mpc (eq.13)	67.74(46) km/s/Mpc [6]
CMB temperature	2.7269K (eq.6)	2.7255K [5]
CMB peak frequency	160.2GHz (eq.17)	160.2GHz [5]
Casimir length	0.42mm (eq.8)	

keywords:
cosmic microwave background, CMB, cosmological constant, black-hole universe, white-hole universe, Planck time, arrow of time, dark energy, Hubble constant, expanding universe, Casimir, Simulation Hypothesis;

1 Premise

The universe simulation hypothesis proposes that all of reality, including the earth and the universe, is in fact an artificial simulation, analogous to a computer simulation, and as such our reality is an illusion [1]. In this article I discuss a method for constructing principal cosmic microwave background parameters applicable to a Simulation Hypothesis, the only variable required being the universe age t.

Let us suppose we initialize a Planck-size micro black-hole that embodies the Planck units. Our simulation begins with a single micro black-hole, time $t = 1$. A second micro black-hole is added, $t = 2$ and so on ... t as the clock rate of our simulation and measured in units of Planck time t_p, the sum black-hole growing in these Planck steps accordingly.

The velocity of this expansion is constant and is the origin of the speed of light. It is also this outward expansion of the sum black-hole that gives an omni-directional (forward) arrow of time.

When the black-hole has reached the limit of its expansion (when it is 1 Planck step above absolute zero), the simulation clock will stop.

If we include an inverse contracting white-hole twin as the source of the micro black-holes, upon reaching near absolute zero the roles could then reverse, the black-hole then becoming a contracting white-hole feeding its (now) expanding black-hole, and so forth ad infinitum.

2 Mass density

Assume that for each expansion step, to the black-hole is added a unit of Planck time t_p, Planck mass m_P and Planck (spherical) volume (Planck length = l_p), such that we can calculate the mass density of this black-hole at any chosen step where t_{age} is the age of the black-hole as measured in units of Planck time and t_{sec} the age of the black-hole as measured in seconds.

$$t_p = \frac{2l_p}{c}\ (s)$$

$$mass : m_{bh} = 2t_{age}m_P \ (kg)$$

$$volume : v_{bh} = 4\pi r^3/3, \quad r = 4l_p t_{age} = 2ct_{sec} \ (m)$$

$$\frac{m_{bh}}{v_{bh}} = 2t_{age}m_P.\frac{3}{4\pi(4l_p t_{age})^3} = \frac{3m_P}{2^7\pi t_{age}^2 l_p^3} \left(\frac{kg}{m^3}\right) \tag{1}$$

Via the Friedman equation, replacing p with the above mass density formula, $\sqrt{\lambda} = r = 2ct_{sec}$ reduces to the black-hole radius;

$$G = \frac{c^2 l_p}{m_P}$$

$$\lambda = \frac{3c^2}{8\pi Gp} = 4c^2 t_{sec}^2 \tag{2}$$

3 Temperature

Measured in terms of Planck temperature = T_P;

$$T_{bh} = \frac{T_P}{8\pi\sqrt{t_{age}}} \tag{3}$$

The *mass*/*volume* formula uses t_{age}^2, the *temperature* formula uses $\sqrt{t_{age}}$. We may therefore eliminate the age variable t_{age} and combine both formulas into a single constant of proportionality that resembles the radiation density constant.

$$T_p = \frac{m_P c^2}{k_B} = \sqrt{\frac{hc^5}{2\pi G k_B{}^2}} \tag{4}$$

$$\frac{m_{bh}}{v_{bh}T_{bh}^4} = \frac{2^5 3\pi^3 m_P}{l_p^3 T_P^4} = \frac{2^8 3\pi^6 k_B^4}{h^3 c^5} \tag{5}$$

4 Radiation energy density

From Stefan Boltzmann constant σ_{SB}

$$\sigma_{SB} = \frac{2\pi^5 k_B^4}{15h^3c^2} \tag{6}$$

$$\frac{4\sigma_{SB}}{c}.T_{bh}^4 = \frac{c^2}{1440\pi}.\frac{m_{bh}}{v_{bh}} \tag{7}$$

5 Casimir formula

The Casimir force per unit area for idealized, perfectly conducting plates with vacuum between them, where $d_c 2l_p$ = distance between plates in units of Planck length;

$$\frac{-F_c}{A} = \frac{\pi hc}{480(d_c 2l_p)^4} \tag{8}$$

if $d_c = 2\pi\sqrt{t_{age}}$ then eq.7 = eq.8,

$$\frac{-F_c}{A} = \frac{c^2}{1440\pi}.\frac{m_{bh}}{v_{bh}} \tag{9}$$

equating the Casimir force with the background radiation energy density. Plotting $d_c 2l_p$ against radiation energy density pressure (fig.1).

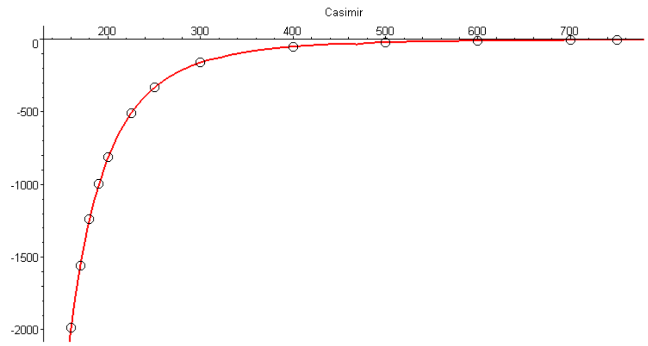

Fig. 1: y-axis = mPa, x-axis = $d_c 2l_p$ (nm)

6 Hubble constant

1 Mpc = 3.08567758 x 10^{22}m.

$$H = \frac{1Mpc}{t_{age}t_p} \tag{10}$$

7 Wien's displacement law

$$\frac{xe^x}{e^x - 1} - 5 = 0, x = 4.96511... \tag{11}$$

$$\lambda_{peak} = \frac{2\pi l_p T_P}{xT_{bh}} = \frac{16\pi^2 l_p\sqrt{t_{age}}}{x} \tag{12}$$

8 Black body peak frequency

$$\frac{xe^x}{e^x - 1} - 3 = 0, x = 2.821439... \tag{13}$$

$$v_{peak} = \frac{k_B T_{bh} x}{h} = \frac{x}{8\pi^2 t_p\sqrt{t_{age}}} \tag{14}$$

$$f_{peak} = \frac{xc}{16\pi^2 l_p\sqrt{t_{age}}} \tag{15}$$

9 Cosmological constant

Riess and Perlmutter (notes) using Type 1a supernovae calculated the end of the universe $t_{end} \sim 1.7$ x $10^{-121} \sim 0.588$ x 10^{121} units of Planck time;

$$t_{end} \sim 0.588x10^{121} \tag{16}$$

9.1. The maximum temperature T_{max} would be when t_{age} = 1. What is of equal importance is the minimum possible temperature T_{min} - that temperature 1 Planck unit above absolute zero, for in the context of this model, this temperature would signify the limit of expansion (the black-hole could expand no further). For example, if we simply set the minimum temperature as the inverse of the maximum temperature;

$$T_{min} \sim \frac{1}{T_{max}} \sim \frac{8\pi}{T_P} \sim 0.177\ 10^{-30}\ K \tag{17}$$

This would then give us a value 'the end' in units of Planck time (~ 0.35 10^{73} yrs) which is close to Riess and Perlmutter;

$$t_{end} = T_{max}^4 \sim 1.014\ 10^{123} \tag{18}$$

The mid way point ($T_{mid} = 1K$) becomes $T_{max}^2 \sim 3.18\ 10^{61} \sim$ 108.77 billion years.

9.2. Using the same approach as above but setting the radiation energy density pressure mid-point at 1Pa gives $t_{end} \sim$ 0.764 $10^{108} t_p$. At the mid-point, Casimir length = 189.89nm (fig.1) and the radiation temperature = 6034K.

10 Comments

In comparing this black-hole with the CMB data, I took the peak frequency value at exactly 160.2 GHz as my reference and used this to solve t_{age} eq(15) and from there the other formulas, as t_{age} = number of expansion steps is the only variable required. This gives a 14.624 billion year old black-hole (see table, page 1).

The above relates to a pure Planck framework, the addition of particles as energy sinks should result in the temperature parameters dropping more quickly and so influence age accordingly. It is estimated that the age of our universe is about 13.8 billion yrs and the matter content is about 5% which corresponds to the age difference (14.6/13.8), this may be a subject for future investigation.

Notes:

The formulas used in this article can be downloaded in maple format at http://planckmomentum.com/

The Schwarzschild metric admits negative square root as well as positive square root solutions.

The complete Schwarzschild geometry consists of a black hole, a white hole, and the two Universes are connected at their horizons by a wormhole.

The negative square root solution inside the horizon represents a white-hole. A white-hole is a black-hole running backwards in time. Just as black-holes swallow things irretrievably, so also do white-holes spit them out [3].

... in 1998, two independent groups, led by Riess and Perlmutter used Type 1a supernovae to show that the universe is accelerating. This discovery provided the first direct evidence that Ω is non-zero, with Ω ~ 1.7 x 10^{-121} Planck units.

This remarkable discovery has highlighted the question of why Ω has this unusually small value. So far, no explanations have been offered for the proximity of Ω to $1/t_u{}^2 \sim 1.6$ x 10^{-122}, where $t_u \sim 8$ x 10^{60} is the present expansion age of the universe in Planck time units. Attempts to explain why Ω ~ $1/t_u{}^2$ have relied upon ensembles of possible universes, in which all possible values of Ω are found [4].

The cosmic microwave background (CMB) is the thermal radiation left over from the time of recombination in Big Bang cosmology. The CMB is a snapshot of the oldest light in our Universe, imprinted on the sky when the Universe was just 380,000 years old. Precise measurements of the CMB are critical to cosmology, since any proposed model of the universe must explain this radiation. The CMB has a thermal black body spectrum at a temperature of 2.72548(57) K. The spectral radiance peaks at 160.2 GHz.

References

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